FOUNDRY TRADE JOURNAL

Established 1902

Vol. 92 Thursday, May 22, 1952 No. 1864

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PUBLISHED WEEKLY: Single Copy, 9d. By Post 11d. Annual Subscription, Home 40s., Abroad 45s. (Prepaid).

49, Wellington Street, London, W.C.2. 'Phone: Temple Bar 3951 (Private Branch Exchange) Grams: "Zacatecas, Rand, London"

Serious Shortage

Whenever we visit foundries, nowadays, we are invariably asked as to the prospect of an amelioration in the supply of hematite iron. This material is an essential commodity for the making of ingot moulds, rolls, and malleable castings, all of which are fundamental to the well-being of the nation. Whilst for other raw materials in short supply we find that there exists a plan or plans for improvement in the future, yet in the case of hematite we have still to hear of any project which will bring about better supplies in the future. There have been, however, promises to " look into the matter."

To alleviate the immediate consequences of the shortage, a prerequisite is for an authoritative national body to say for what castings hematite is or is not really necessary. This might result in better supplies becoming available for one foundry to the detriment of a second. There should then be a reasoned statement as to the provision of substitutes. The modern foundry can do something in this direction by melting an all-steel charge, plus ferro-alloys, in the cupola. It may be necessary to desulphurize with soda ash and to cast into pig beds for re-use, and thus follow the practice of the refined-iron makers. However, the job of the foundry is to manufacture castings and not pig-iron. One jobbing ironfounder, making really important high-priority castings, being unable to get hematite, is not too happy about substitutes as it had taken him time and trouble to fulfil his customers' important requirements. He is in no position to experiment and can only rely on " badgering " the Ministries for assistance. In the ironfoundry industry it should be realized that some foundries considering the use of substitute material need metallurgical help, otherwise they will be unable to meet their customers' needs. Wartime experience taught how difficult it is to impose limitations on choice of raw materials and tact and mutual goodwill are necessary. In this sphere an advisory team could provide a solution.

However, these are interim measures only and the overall shortage must not be regarded as temporary, as these conditions will persist unless the situation is tackled very energetically by every interested party. Very many industries are involved, especially when one includes the consumers' requirements. It is essential that all complaints be canalized through the Council of Ironfoundry Associations as the situation is not devoid of pitfalls. The main objective should be directed towards a greater supply of hematite pig-iron for therein lies the ultimate solution.

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National Federation of Iron and Steel Merchants

The annual general meeting of the National Federation of Iron and Steel Merchants, was held at the May Fair Hotel, London, W.1. The independent chairman Mr. W. H. Lawson, C.B.E., F.C.A., took the Chair and gave an address in the course of which he referred to the great loss which the industry and the country has suffered by the death of Sir Andrew Duncan. He then said that members were now awaiting the publication of the Government's Bill for de-nationalization and regulation of the steel industry. They would, of course, give careful consideration to the Bill when it appeared. It was hoped that it would not contain any provisions adverse to the interests of merchants but the position would require to be watched and if there was any opportunity of proposing amendments which help the cause of the merchant, members could be sure that their council would take the appropriate steps both direct with Government and through Parliament.

It seemed clear that a new Board would be set up to control the affairs of the industry and it would be their wish to make contact with that Board at the earliest opportunity in order to ensure that the part which merchants could usefully play is brought to the attention of those who will, in future, carry responsibility for the industry. However that may be, the merchant must, in the end, depend for his success upon providing useful service to makers and customers alike. The Federation had never asked for special privileges for the merchant but had endeavoured to establish the right for the merchant to exercise freely his proper function in the industry. The present aims might be stated briefly as follow:—

(*a*) The right of any consumer either at home or abroad to buy from a merchant.

(*b*) The right of any maker to sell through a merchant and to allow him a discount off the schedule price.

(*c*) No buyers, including merchants, to be placed at a disadvantage compared with official trading companies.

As a result of the approach to the Minister of Supply, Mr. H. Basil Darby, chairman of the Steel Distributors' Association, was appointed a member of the Consumers' Council set up under the Iron and Steel Act, 1949, as a representative of the Direct Trade Merchants. Two representatives of the National Association of Iron and Steel Stockholders were also appointed to the Consumers' Council. The future of that Council was, of course, dependent on the terms of the new Bill.

The Federation had now become an observer member of the International Federation of Steel, Tubes and Metal Merchants and Mr. Annetts, chairman of the National Association of Iron and Steel Stockholders, regularly attended meetings of that body.

RESEARCH INVESTIGATORS from Sheffield University have visited almost 60 steelworks in the city in an endeavour to find a solution to the problem of how Sheffield steelworks could reduce smoke. Under the guidance of Prof. R. J. Sarjant, head of the fuel technology department, experimental work is being carried out in a workshop laboratory near the University.

A REQUEST that Saturday working be abolished during the winter is to be submitted to the Wear Shipbuilders' Association by the Wear district of the Confederation of Shipbuilding and Engineering Unions, which represents 10,000 shipyard workers in Sunderland. The decision follows a ballot of affiliated unions which wish to negotiate for a five-day week for the whole year.

British Standards Institution

Methods for the Sampling of Ferrous Metals and Metallurgical Materials for Analysis, Part I Iron and Steel

The British Standards Institution has recently published B.S. 1837: 1952, intended for use in conjunction with B.S. 1121, "Methods for the analysis of iron and steel," and those specifications which include clauses governing chemical composition and sampling. Section 1 sets out the general requirements, Section 2 deals with liquid iron and liquid steel, Section 3 covers the sampling of pig- cast and wrought iron, and Section 4 includes the sampling of steel in the form of ingots, castings, blooms, billets, slabs, heavy sections, plates, light sections, bars, rods, wire, sheet, strip and tubes.

The methods are those which have been found most satisfactory in practice. As is the purpose of the methods of analysis specified in the various parts of B.S. 1121, the standard is primarily intended for referee purposes and should be considered as a guide to sound sampling procedure rather than as a rigid specification. Copies of this standard may be obtained from the British Standards Institution, Sales Branch, 24, Victoria Street, London, S.W.1. Price 2s. 6d.

East Kilbride Development Postponed

The American firm of John Deere & Company have decided to suspend the programme in connection with the proposed new factory at East Kilbride owing to the expansion of their works in America and Canada. Their output of machinery in Canada has increased from 25,000 to 50,000 tons a year and further increases are anticipated. In April the Board of Trade announced that construction would go ahead as planned.

Expansion of trade in the U.S. and Canada will make it difficult for the Company to start manufacturing in East Kilbride, or elsewhere in Europe. The Company, which manufactures agricultural machinery, would have gone ahead with the original scheme if they had been allowed to start operations in January as at first arranged, but continued postponement owing to the shortage of steel apparently influenced the directors to suspend the scheme for manufacturing plant. The loss of this new factory will be compensated to some extent by increased employment in the new Rolls-Royce factories in East Kilbride which are now to give work to 4,500 instead of 2,000 as at first suggested. There are 20 firms on the waiting list for factories in the new town.

Second Hot-dip Galvanizer's Conference

The second international conference on hot-dip galvanizing is to be held at Düsseldorf from June 30 to July 4, under the auspices of the Zinc Development Association. Papers to be discussed range from those dealing with fundamental questions such as coating structures and electrochemical behaviour to practical questions of bath heating and operation. There is to be included a Paper on fluxing by A. T. Baldwin, one on the flaking of hot-dipped zinc coatings, and a Paper by Mr. W. Montgomery, of Frederick Braby & Company, Limited, entitled "Galvanizing of Iron Castings." Additionally there is to be a number of works visits and social events. Full details may be obtained from the organizers at Lincoln House, Turl Street, Oxford.

Synthetic Resins in the John Harper Foundry*

By J. W. Dews and P. H. Drury

John Harper & Company, Limited, are amongst the first high-productivity founders in this country to take advantage of the benefits accruing from the use in suitable applications of synthetic-resin corebinders. Basing their experiments and eventual large-scale operation on the use of a proprietary urea-formaldehyde liquid resin, much success has been achieved. Details of Harper's observations which are of benefit to other founders contemplating the use of resins are recorded in this Paper.

Preliminary Work

The introduction of any new material into the foundry invariably meets with many difficulties, either from the new techniques that require developing or from the understandably conservative outlook of the operators. The introduction of synthetic-resins for corebinding at the foundries of John Harper & Company, Limited, has proved no exception.

Work on synthetic resins at Willenhall has covered a period of some four years, from a time when little was known of the value of these resins, to the present time when somewhere between 40 per cent. and 50 per cent. of the coreshop production is being made in a synthetic-resin mix. It should be fairly stated, at once, that much of the work involved, has been carried out in close co-operation with the resin manufacturers,† who have modified, altered and improved their products as new difficulties arose. In general, liquid resin has been used although trial batches of powdered resin have been prepared experimentally. Both phenol-formaldehyde and urea-formaldehyde resins have been investigated and without doubt the U.F. resins give the best results. U.F. resins are much cheaper and in some respects have greater applicabilify, and at the present time are much more readily available.

Advantages

Many reasons have been advanced in the technical Press, for the extended use of synthetic resins, and in the 18 months to two years that Harper's have been using synthetic resin, their experience has confirmed the following:—

(1) Synthetic resins are comparatively cheap, being considerably cheaper than linseed oil.

(2) They are more readily available and are manufactured in this country from indigenous raw materials. Production is not dependent on imported materials or on the vagaries of a foreign nation. They can also be obtained in any desirable or convenient quantity from a few gallons up to tanker loads.

(3) They give at least equal green-strength when compared with linseed oil for bonding cores.

(4) More than adequate dry-strengths can be easily obtained.

(5) Lower curing or baking temperatures are necessary.

(6) Much shorter drying times can be used.

(7) Resins lend themselves to di-electric or high-frequency short-time curing processes.

(8) Lower fettling costs for castings result from their use.

Knock-out Characteristics

P.F. resin-bonded cores do not show any advantage over linseed oil during knock-out. On the other hand U.F. resin cores give a marked and decided advantage. Due to the fact that urea-formaldehyde resin cores break down so easily after casting, there is much less danger from cracked castings, or castings with residual stresses, which arise when the normal contraction of a cooling casting is intercepted or prevented by a core which refuses to collapse. Core removal, with U.F., is very good, in some cases the core can be poured from the casting in the form of a dry powder. Further, the characteristic cracking of the core and consequent finning of the casting with oil-bonded cores is completely eliminated with U.F. This reduces cleaning-shop operations and also produces a better looking casting.

Other Characteristics

The permeability of both U.F. and P.F. resin-bonded cores is higher than linseed-oil cores both in the "green" and "dry" state, due no doubt to the reduced amount of green-strength binder that is found to be necessary. Due also to the high degree of thermal reactivity shown by these resins, high-frequency drying can be used with great success. During drying, the binder migrates to the outside and so produces a core with a very hard and smooth surface, and a comparatively soft centre. This produces a casting with a very good finish on the face next to the core and also gives a certain amount of freedom from burned-in sand, a feature of prime importance on certain classes of work.

Production of Synthetic-resin in Cores

The type of urea resin now in use at Harper's is a thermo-setting liquid plastic of a very low viscosity, specifically designed for core-binding. Its low viscosity makes it very easy to handle in the coreshop. Under the action of heat, it hardens

* Paper presented to the Mechanite Research Institute and reproduced by permission. The Authors are on the staff of John Harper & Company, Limited, Willenhall, Staffs.
† Beetle Bond, Limited.

Synthetic Resins in the John Harper Foundry

irreversibly into an insoluble and infusible state. This hardening is a polymerization process, resulting in a chemical change, and is completely different from that of the hardening of linseed oil, which is primarily an oxidation process, requiring the presence of air and also a longer time for its completion.

All U.F.-bonded mixes in routine production are made in a Fordath "Rotoil" type of core-mixer, and no oil-bonded mixes are allowed through this mixer. This is to prevent contamination between the two types, which can cause trouble. The standard routine core-mix now in regular use is:—

Dried silica sand	380 lb.
Red sand (10 per cent. clay content)	20 lb.
Dextrin	5 lb.
U.F. resin	4 pints
Wetting agent: 25 ml. in 2 pints water.	

The sand is first put into the mixer, followed by the resin and the water to which the wetting agent has been added). This is given approximately 2 min. mixing to enable the sand grains to be effectively coated. The dextrin is then added and mixing continued for a further minute. If the dextrin is added first, the green-strength of the mix is very quickly developed and subsequent coating of the sand grains by the resin is very difficult and the dry-strength of the cores is deficient.

Curing Times and Temperatures

U.F. resin cores are cured in a coke-fired, continuous vertical-type core-oven. This oven when previously in use on linseed-oil cores had a drying cycle of 125 min., and a temperature of 220 to 230 deg. C. Since using U.F. cores, the stove has been altered to a 60-min. cycle, with a temperature of 170 deg. C. If this temperature is exceeded, small cores show signs of urea decomposition and give off a fishy smell. A well-cured core, when removed from the stove, should have a slight smell of formaldehyde, which disappears within a few seconds.

Sand Used

As with other binders, it is found that synthetic-resins give higher dry-strengths with coarser sands; this, of course, being a function of surface area and grain size. Harper's have found in practice that a fine silica sand, well dried, gives good results if the clay content is kept below 0.5 per cent. A typical sieve analysis for this sand is:—

Sieve mesh.	Per cent.	Sieve mesh.	Per cent.
22	0.2	120	9.7
30	1.1	150	9.7
44	7.2	200	5.9
60	21.5	Pan	1.5
100	43.2	Clay	Nil

To a sand of this grain size is made a 5 per cent. addition of red sand which contains 10 per cent. clay. It is found that this addition increases the green-strength of the mix, and also helps to reduce the inherent stickiness of U.F. resins. The clay content of the mix must be carefully controlled, however, because excess clay absorbs resin and reduces the ultimate dry-strength. As far as possible, the sand should be free of calcium carbonate, *i.e.*, sea shells, etc., which have an alkaline reaction, for alkalinity has a detrimental effect on the hardening properties of resins. This may cause the resin to decompose during drying.

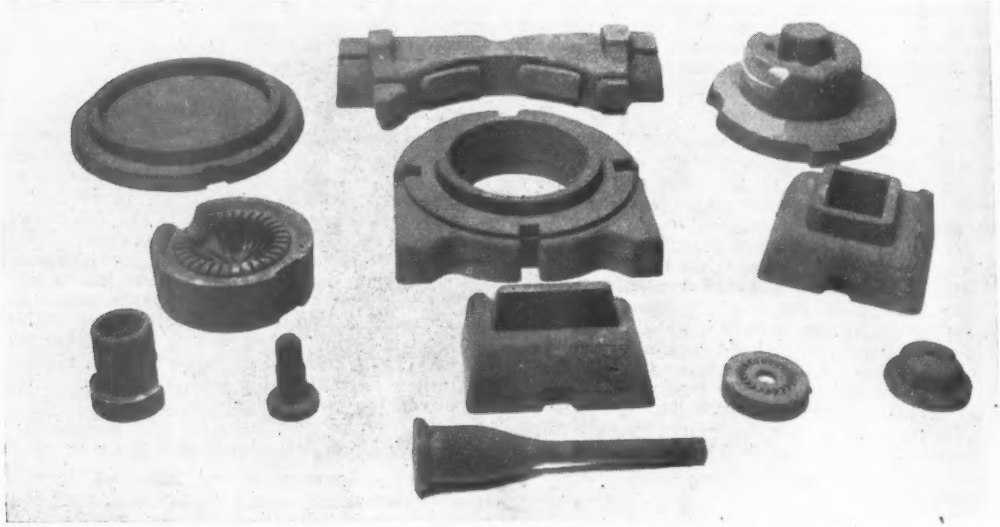


FIG. 1.—*Group of Synthetic-resin-bonded Cores of the Smaller Types which are in Regular Production at the John Harper Foundry.*

Green Strength and Moisture

Most work on the green-strength of U.F.-resin cores has been done when using a cereal binder. This practice is also recommended by the resin manufacturers on the ground that the use of a cereal binder permits a higher moisture content and consequently a higher dry-strength is obtained. This high moisture content, however, produces a sticky mix which is hard to work, and also makes stripping from either wood or metal core-boxes very difficult. High moisture content also entails a longer drying time, because all the moisture has to be driven off before the core can be cured. Possibly, this high moisture content and consequent stickiness is the reason why many foundrymen have allowed their interest in resin binders to fall off. The firm have secured very good results by adding dextrin as a green-bonding agent. This is not looked upon as good practice because some dextrins are supposed to contain small quantities of acid, which promotes hardening and reduces the bench life of the mix, although it has not been Harper's experience. It has been found possible to obtain improved green-strength, when compared with an equivalent oil-bond mixture, by reducing the dextrin content from 8 lb. in the oil mix to 5 lb. for the resin mix. This at once makes a direct saving and at the same time increases the permeability both in the "green" and "dry" state. Using dextrin, of course, a low moisture content is permissible, and therefore to maintain dry-strength figures it is imperative that the maximum use be made of the available water content. This is accomplished by making a small addition of the wetting agent, and so ensuring that every sand grain receives a thorough wetting.

It is routine to maintain a final moisture content of the mixture of 1.0 per cent., taking into account the water content of the U.F. binder which is approximately 45 per cent. During the last twelve months, this moisture content has been held within a tolerance range of 0.3 per cent.

Physical Characteristics

For investigation, two core-mixes were used, one the firm's standard linseed-oil mix, and the other, the new standard U.F.-resin mix as follow:—

Linseed-oil Mix.		*U.F.-resin Mix*	
Silica sand (dried) ..	380 lb.	Silica sand (dried) ..	380 lb.
Red sand (10 per cent. clay)	20 lb.	Red sand (10 per cent. clay)	20 lb.
Dextrin	8 lb.	Dextrin	5 lb.
Proprietary core-compound	1 pint	*Ferric-oxide	4 lb.
Linseed oil	3 pints	U.F. resin	4 pints
Water	4 pints	Wetting agent ..	25 ml.
		Water	2 pints

* Used on heavy jobs to prevent pre-collapse of core and to stop veining and metal penetration.

Tests were carried out externally and reported on as follows:—

Method of Test.—Standard sand specimens were prepared and dried—linseed-oil cores for 1 hr. at 220 deg. C.; U.F.-resin cores for 25 mins. at 195 deg. C. Test cores were then loaded to 20 lb. per sq. in. pressure and lifted into a heated furnace. The time interval before collapse was noted. The results were as shown in Table I.

TABLE I.—*Comparative Behaviour of Linseed and U.F. Resin-bonded Cores.*

Sample.	Moisture, per cent.	Green-perm., lb. per sq. in.	Dry-perm., lb. per sq. in.	Green-comp., lb. per sq. in.	Dry-comp., lb. per sq. in.
Linseed ..	1.0	65	85	2.9	890
U.F. resin	1.0	91	110	3.7	810

Temperature, deg. C.	Time to collapse, in secs.	
	Linseed.	U.F. resin
1,460	65	30
1,315	40	40
1,300	40	45
1,200	53	60
1,150	77	60
1,100	85	65
1,050	87	55
1,000	80	62
950	75	65

Conclusions.—Table I indicates that the linseed-oil bonded specimens frit at about 1,400 deg. C. and collapse at about 1,300 deg. C. The U.F.-resin specimens do not frit at any temperature tested and have a lower dry-strength, generally, at low temperatures. This report confirms the improved permeability obtained with a slightly-increased green-strength, at the same time effecting a considerable saving in the dextrin addition. The collapsibility tests also confirm the findings in the foundry that U.F.-resin cores break down very much more easily after casting than those of linseed oil. In addition, the fact that fritting does not take place at any temperature used in the tests shows why burned-on sand is practically eliminated, when these cores are used.

Washes and Spraying

It is stated in literature and recommended by manufacturers that U.F.-resin cores should be sprayed with water just before curing so that the surface of the core will harden like concrete. In all cases it is found that this practice is adopted where a starch binder is used in conjunction with the resin. The phenomenon would appear to be affected by atmospheric conditions. Using a starch binder, a moisture content of about 4.00 per cent. is usual, and if these cores are allowed to stand for any length of time before baking, the moisture on the surface will dry out. This produces a friable core surface, and as a precaution spraying with water is resorted to. The Authors have found that water spraying just prior to baking has produced a hard shell of sand about $\frac{1}{16}$ in. thick on the surface which could very easily be peeled off.

The use of dry sand which is still warm from the drier will also obviously cause fluctuations in the moisture content of the finished mix and produce a poor core. Care should be taken to see that sufficient stocks of dried sand are available to ensure the use at all times of cold sand. The use of cold sand is essential even when a dextrin binder is used. Atmospheric conditions, however, are not so critical with the low-moisture content of the mix when using

dextrin, and, in fact, the cores hold sufficient moisture on the surface for them to stand two hours before baking, before any drying off is detected. The firm does not now spray any cores. For this reason, too, any protective coatings which are required, such as blacking or Steelmol, are applied after removal from the stove, while the core is still warm.

Parting Materials

Many parting materials have been suggested to overcome the natural stickiness of U.F.-resin-bonded mixes, including, fuel-oil, paraffin, soft soap and ethylene glycol. Some are mixed in with the sand and others are either sprayed or wiped over the core-box. As has been already shown, the higher the water content the more sticky the mix, and by using dextrin and a low moisture this is largely overcome. The urea-formaldehyde mix developed is now very similar in bench and working properties to the equivalent linseed-oil mix. When using either mix, the same parting procedure is used—on wooden coreboxes a shake of non-siliceous parting powder and on metal coreboxes a wipe over with a rag dipped in linseed oil that gives excellent stripping.

Storage of Baked Cores

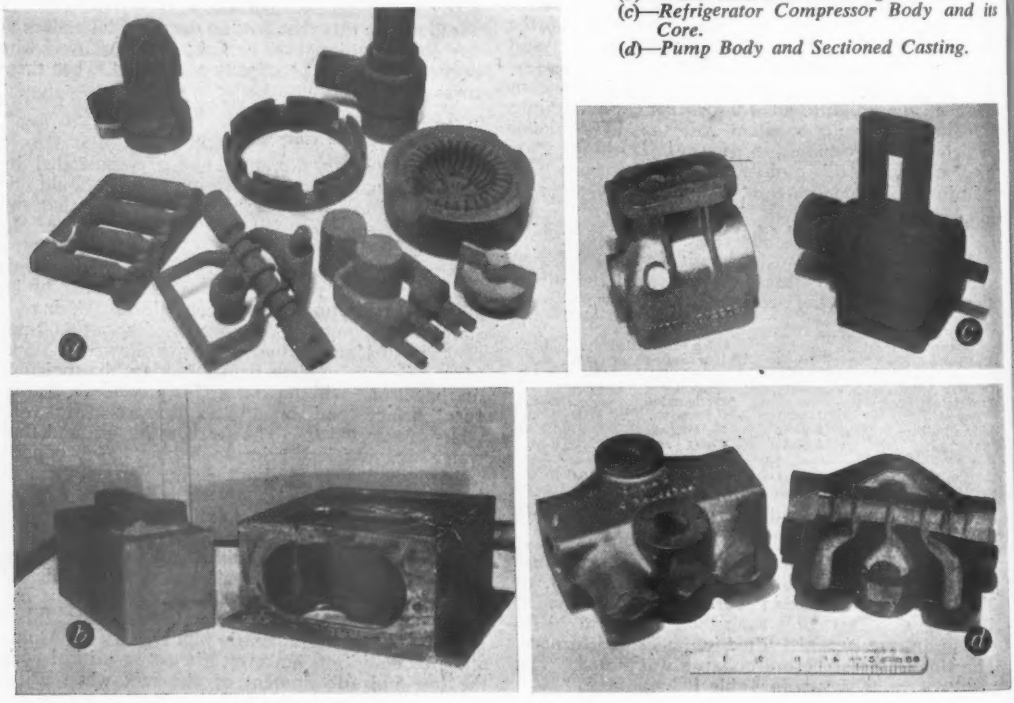
Providing that U.F. cores are stored in a dry place, they can be kept for several months without deterioration. It should be noted, however, that they do not appear so satisfactorily to withstand a damp atmosphere as oil-bonded cores. Tests carried out by dipping cores into water showed that the U.F. cores pick up about three times as much water as a linseed-oil core. Green-sand moulds have, however, been cast satisfactorily, which have been cored-up with U.F. cores and allowed to stand over-night until casting time the following day. This is not recommended practice with any core but in some circumstances is unavoidable.

Very little work, as yet, has been done on core-blowing with U.F. core-sands, but from the few trials that have been carried out the firm do not anticipate any serious difficulties. It is believed, however, that core-blowers which incorporate agitation of the sand in the reservoir will be unsuitable as this develops too high a green-strength in the sand.

Obnoxious Smell

Many set-backs and disappointments were experienced before a really good U.F. resin core-mix was developed. The Authors were not surprised therefore, when the first production trial of the material in the foundry, produced almost universal condemnation because of the obnoxious smell of decomposing urea, which filled the foundry

FIG. 2.—*Urea-formaldehyde-bonded Cores* (*a*), *and Applications in Castings for which their Special Properties are Extremely Valuable.*
(*b*)—*Water-tube Boiler Casting and Core.*
(*c*)—*Refrigerator Compressor Body and its Core.*
(*d*)—*Pump Body and Sectioned Casting.*



immediately the moulds were cast. The manufacturers suggested various reasons and remedies and even produced resins with an aromatic content in an endeavour to mask the smell. None was successful, the aromatic oils distilling off at lower temperatures and thereby losing their effect.

Nevertheless, the Authors persisted in attempts to get the resins adopted for production cores, believing that, objectionable as the smell was, it was nothing like so harmful as the acrid and choking fumes produced by burning linseed oil. It would seem that careful attention to the following three points greatly improves matters:—

1. Baking time and temperature must be carefully controlled to ensure the final and complete curing of the core. All formalin fumes should have disappeared up the stack of the stove.

2. A satisfactory mix should be developed and then adhered to strictly, maintaining its physical properties.

3. A low-viscosity resin should be selected, the solid content of which is not so high as in a high-viscosity resin. The less solid resin there is present the more easily is the core cured.

By using this binder selected and paying attention to these points, it is now true to say that it would be impossible for anyone to walk through the foundry and detect that the firm is using urea-formaldehyde as a core-binder. Once a moulder has used U.F. cores it is very difficult to get him back to linseed-oil cores. This sometimes happens, because production of U.F. cores is at present limited by the inability to obtain sufficient supplies of suitable dry sand. It is the Authors' opinion that almost any core can be made, using this binder. Figs. 1 and 2 (*a*) show a selection of small cores in daily production at John Harper's foundry.

Production Examples

The particular advantages to be obtained from the use of synthetic resin, additional to that of cost, can be seen from the following examples:—

Water-tube Boiler Casting.—The casting shown in Fig. 2 (*b*) for a water-tube boiler is made in a heat-resistant white iron so as to withstand the service conditions imposed—which also include very close tolerances dimensionally. When using a linseed-oil-bonded core, trouble was experienced with hot-tears due to the restriction of the body core to normal shrinkage. There was also a serious risk of broken castings arising when the core was knocked-out. This job is now made with a synthetic-resin core, which due to its early and easy break-down allows the casting to contract normally, entirely eliminating both hot-tears and residual casting stresses. Knock-out, too, is now very easy and the risk of broken castings is negligible.

Refrigerator Compressor Body.—This casting and the synthetic-resin core used for it is shown in Fig. 2 (*c*) and the "finning" defect that previously resulted from the use of an oil-bonded core for this job can be seen in Fig. 3. All of this excess metal has to be removed in the fettling-shop, because the refrigerator manufacturers insisted on perfectly clean castings, especially in the body and through the bores. Fig. 4 shows a similar view of the same job when made with a U.F-resin core. The general surface finish is much improved and "finning" is entirely eliminated. This casting is now going through the fettling shop as an ordinary routine job and is typical of those which show a definite saving on fettling costs and where the customer gets a more satisfactory casting.

Pump Body.—Fig. 2 (*d*) shows this job, together with a sectioned casting which reveals the sort of skin finish obtained from a U.F-resin core. Fins of metal which were always present previously when using a linseed-oil core, were difficult to remove. In fact, some which could not be removed were known subsequently to come adrift when the pump was in service, causing serious damage. This casting, as made with the new cores, had the core wires removed in the usual way and was given only a normal shotblasting before being sectioned.

These three examples demonstrate particular advantages that have been obtained by the use of

(*Continued on page* 550)

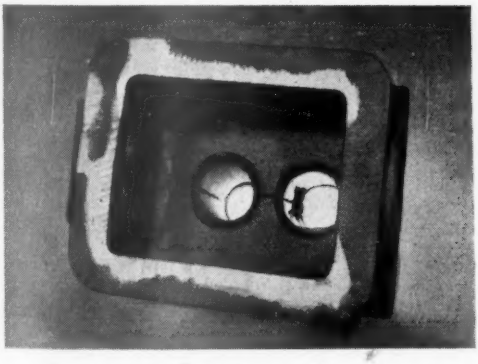


FIG. 3.—*Refrigerator Compressor Body Casting when made with an Oil-bonded Core, showing the "Finning" which resulted.*

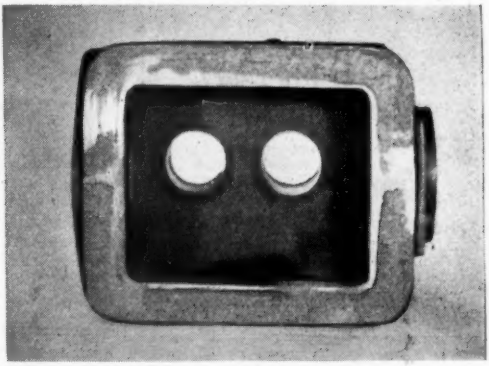


FIG. 4.—*Refrigerator Compressor Body made with U.F.-resin bonded Core showing Clear Bores and Freedom from "Finning."*

Worshipful Company of Founders

Visits to Midlands Foundries

An event of peculiar interest linking the City of London with the Midlands took place recently, when the Master and Wardens, together with a large number of Liverymen of the Worshipful Company of Founders (a Guild founded over 600 years ago by the Brass Founders of the City of London), paid a three-day visit from May 6 to 8 to well-known foundries in that area.

On the first day, the party visited Stanton Ironworks where they saw a very well-equippel training centre of particular advantage to the training of foundry craftsmen. They were also shown a highly-mechanized foundry which, during the war, produced the major proportion of aerial steel bombs, and which has now been converted to the production of grey-iron castings. They also visited one of the Company's spun iron pipe plants, where they had an opportunity of seeing in detail this method of production and also the firm's concrete plant producing, by centrifugal method, pipes of a large range of sizes. The Liverymen were particularly interested in their latest application of pre-stressed concrete in connection with the manufacture of street lighting standards.

On the second day a visit was paid to Ley's Malleable Casting Company works at Derby. This company produces a wide variety of malleable castings mostly by mechanical methods and the Liverymen had an opportunity of seeing the whole production from the melting to the moulding and finishing; some of the castings were of a very complicated design.

The third day was spent visiting the Staveley Iron and Chemical Company's works, near Chesterfield, and the visit was concentrated on their up-to-date blast-furnaces, coke ovens, and the various by-product plants, producing a variety of basic chemicals.

The Liverymen stayed one night at Nottingham. *En route* from Derby to Buxton, where the second night was spent, they journeyed through the beautiful parts of Derbyshire, a certain amount of time being spent at Haddon Hall and Chatsworth Park. During the visit of the different works they were cordially received by the directors of the three Companies.

This visit is the second annual visit by the Company to foundries, their visit last year being to other works in the Midlands. It is intended that these visits should be continued in future years. The Founders Company encourages education and training in the foundry industry and for some years has awarded Fellowships to attract to the industry suitable young men. Recently Mr. Robert Warner, a past-master, left his estate to the Company for the purpose of founding research fellowships in metallurgy still further to encourage this all-important technical training in the industry.

Members of the Worshipful Company of Founders, with members of the Staff of Ley's Malleable Castings Company, Limited, during the Visits of the Company to Midland Foundries.

From left to right: (*Back row*) Mr. J. L. Wheeler, Mr. C. H. Wilson, Mr. S. A. Horton, Mr. C. C. Booth, J.P., Mr. H. B. Young, Mr. J. C. Thomson, Mr. H. Newton-Knights, Mr. A. C. Jennings, Mr. A. K. Kirk, Mr. J. A. Roxburgh, Mr. J. Hill, Mr. R. B. Templeton, Mr. C. H. Kain, Mr. Wilson Wiley; (*Front row*) Mr. E. H. Parkinson, Mr. J. W. Gardom, Mr. John Booth, Lt.-Col. R. C. Scott, Mr. E. H. Mitchell, Mr. D. Howard Wood, Mr. A. P. L. Blaxter, Mr. L. E. Cotterell, Mr. C. W. Bigg, Mr. G. B. Cotton, Mr. A. E. Peace and Mr. W. G. Fossick. (Mr. F. Arnold Wilson took the photograph.)

THE BRITISH ELECTRICITY AUTHORITY has announced that the overall average thermal efficiency of its steam power stations for 1951 was 21.79 per cent., compared with 21.53 per cent. for 1950. This represents a saving of more than £1,000,000.

THE FIRST of a pair of dock gates constructed by Head, Wrightson & Company, Limited, at Thornaby-on-Tees for the Port of London Authority's King George V dock was launched last week and despatched by sea to the Thames.

Some Casting Problems of Copper/Lead Alloys*

Discussion of the Paper by P. D Liddiard and P. G. Forrester

As would be expected at a joint-meeting, where perhaps the metallurgical contingent outnumbered the practical foundrymen, the discussion proved to be highly technical. Subjects mainly concerned with were comparisons between British, European and American bearing alloys and applications; copper/lead vis-à-vis Babbitt metal; suitability of copper/lead in special applications; effect of tin content and substitute materials. The more practical aspects dealt with included accommodation for different contractions; segregation and methods of locating this defect and quenching in molten aluminium or lead.

At a meeting of the London branch of the Institute of British Foundrymen held jointly with the London section of the Institute of Metals, at the Waldorf Hotel, London, the president of the foundrymen was accompanied by Mr. Randall (chairman of the London section of the Institute of Metals). This, joint meeting between the two institutes is held annually and the foundrymen, as hosts on this occasion, offered a warm welcome to the London members of the Institute of Metals.

The Paper "Some Casting Problems of Copper/Lead Alloys," was presented by Mr. P. D. Liddiard, B.Sc., F.R.I.C., A.I.M., and Mr. P. G. Forrester, M.Sc., A.I.M., both of the Glacier Metal Company, Limited, Alperton. The CHAIRMAN, introducing the Authors, said Mr. Liddiard began his career in the heavy chemicals industry and, in 1945, joined the Glacier Metal Company as metallurgist, under Mr. Holligan. In 1947 he had been appointed works manager of one of the factories of the Company, working particularly on the sintering of copper/lead alloys. Mr. Forrester began his career working on copper-base alloys with Thomas Bolton & Company, Limited, from 1938 to 1940 and was with the Tin Research Institute from 1940 to 1948, doing research work on bronzes, etc., afterwards joining the Glacier Metal Company. This Company were very fully engaged in the production of bearings by a variety of processes.

[The Paper was then delivered by Mr. Liddiard]

DISCUSSION

MR. P. T. HOLLIGAN said a matter which had puzzled him was that the tin did not distribute itself in the molten condition according to the law of partial solubility. Commenting on the Authors' reference to the so-called detrimental effect of phosphorus on thermal conductivity, he said he was inclined to feel that it was perhaps exaggerated so far as engine performance was concerned. Great attention was paid by some American authors to conductivity, and the great benefit of silver in that respect had been very much emphasized, but the fact remained that the Americans, having produced a bearing, with silver, of extraordinarily high thermal-conductivity, then coated the bearing surface with lead.

He suggested that one of the reasons why the Germans had developed processes of which the Authors had spoken was the shortage of non-ferrous materials—not only of tin, but of copper. The team with which he had visited Germany had seen most amazing bearings, of copper/lead on steel, which on the basis of man/hours must have been very costly. The Germans had been driven to such practices by the shortage of non-ferrous metals. The bearing assembly was subsequently re-heated in order to ensure good bonding.

It was very interesting to hear that high pressure was possibly the explanation of the removal of gas bubbles, and so on, in the assembly. That process was used for the manufacture of the biggest copper/lead-lined bearings he had ever seen; particularly he had in mind some bearings about 6 ft. long by about 15 in. bore dia.

Another important point was that the Germans had limited their lead content in general to very considerably below the figure which was current practice in this country. Whereas we aimed at about 30 per cent. lead, the Germans commonly worked to from 24 to 25 per cent. When he had asked why that was so, they had replied quite honestly that it was because it was very much easier to do that.

German Practice

MR. FORRESTER, replying to the question concerning tin solubility, said all would agree that in the liquid state, *i.e.*, up to the limit of 36 per cent. of lead, the lead, copper and tin were evenly dispersed in one another and there was a perfectly homogeneous liquid. As it passed into the solid state there must be some division of tin between the copper and lead, but the amount of tin in the lead was a very minute amount.

Expressing agreement with the view that there had been a tendency to over-emphasise thermal conductivity, he said that although an enormous amount of work had been done on the bearing properties of metals, a good deal remained to be discovered, and he often suspected that when talking of bearing properties we tended to think of all the things that could possibly affect a bearing and to assume a major effect from all of them.

It was true that the Germans had used copper/lead in many cases where Babbitt metal would

*Paper published in last week's JOURNAL.

have served, simply because they had not the tin to put into Babbitt. Nevertheless, they had used relatively high-tin, low-lead, copper/lead alloys—5 per cent. of tin and 22 per cent. of lead—whereas we had favoured the low-tin, high-lead alloys. Perhaps Mr. Holligan could throw some light on that.

The gas pressure theory was put forward rather tentatively. It had been supposed that the gas bubbles were replaced by lead, and not by copper, in the course of the baking process.

MR. CARTLAND commented that when he had heard the references in the paper to all the snags and difficulties encountered in the casting of copper/lead alloys, he had felt pleased that he was concerned rather more with the making of bearings in white metal; there were plenty of troubles in connection with white metal, but apparently not half so many as in the casting of copper/lead.

Everyone would admit, he believed, that white metal had passed its limit in the very highest duty bearings, such as those used in aeroplanes; and he asked the Authors what proportion of modern aeroplane-engine bearings were made in copper/lead, as compared with the proportion in white metal or other materials. He also asked whether there was an application for copper/lead bearings in jet engines, for copper/lead would stand up to higher duty than would any white metal.

In connection with white-metal bearings, he had always been very concerned with the bonding of the bearing metal to the shell, and he asked whether the physical strength of the bond was the really important factor, or whether we needed merely a molecular contact to prevent any lack of continuity of heat dissipation, or to prevent oil or anything else getting in.

The thickness of the linings of the finished bearings was a rather critical and important point in white metals, and he wondered whether that was also the case in copper/lead. Possibly it was not so important in the latter case, because in white metal the fatigue failures constituted the greatest danger, and the thinner the film of white metal—within the limits of thinness to which one could machine—the better.

Possible Disadvantage

It had always been said that a disadvantage of copper/lead, as compared with tin-base white-metal, was that it scored the shafts, and he wondered why that should be so. It had been suggested that in copper/lead the pools of lead were so small and discontinuous that any steel chips and filings that were formed became embedded in the pools of lead, but still held up against the shafts, thus scoring them, whereas in white-metal those steel chips or filings became embedded in the matrix of the white-metal and did not score the shafts. The essential difference was that in copper/lead alloys the soft metal was a discontinuous phase, whereas in white-metal the soft metal was the continuous medium.

Confessing that he was mystified by the Authors' references to tin contents, Mr. Cartland said that on the Continent and in this country tin contents up to 1 or 2 per cent. in copper/lead were used without deleterious effects, whereas in one American specification the maximum tin content was as low as 0.001 per cent.

Finally, with regard to the lead in the copper/lead molten alloy segregating by gravity in the ladle, he said that apparently, when the alloy was poured, the lead came into the bearing last and did not get to the shell, where it would deteriorate the bonding. That seemed to be a precarious way of getting the lead into the right place, and he asked for more information.

Bond Strength

MR. FORRESTER suggested that Mr. Holligan might be better able to answer Mr. Cartland's first two questions. With regard to bonding, it was the Authors' view that both mechanical strength and continuity were essential in any type of bearing. The bond must give as good support as possible to the actual bearing metal. None of the commonly-used bearing metals had sufficient strength on their own account to resist fatigue or spreading, and they needed support; therefore, it was of importance that the bond should be at least as strong as the bearing metal itself.

It was true that the thickness of the lining was of rather less importance in copper/lead than in Babbitt metal bearings. Copper/lead had a considerably higher fatigue strength at bearing temperatures, and it could be used as a thick lining. Nevertheless, it was common practice to use linings in thicknesses down to 0.020 in. and up to a thickness of 0.070 in. or 0.080 in.

Scoring

There was a greater tendency to shaft scoring by copper/lead than by white-metal bearings, particularly with the softer variety of shafts. The point about "embedability" was sound, that the filings had not the same chance to become really embedded in the lead pools in copper/lead as in the matrix of the Babbitt bearing. Another point was that the tendency of a bearing to maintain its fluid film lubrication was dependent to some extent on its hardness, and just as copper/lead had higher fatigue strength at bearing temperatures, it had greater hardness than Babbitt, which made it rather less easy to maintain a fluid oil film; if that fluid film broke down, some scoring would develop.

The Authors would not suggest that tin content had no deleterious effects on copper/lead. In many applications, and particularly with hard shafts, high tin content had been used quite successfully if the loading were relatively light, but with high loading on relatively soft shafts the tin content of the bearings should be kept fairly low. One could tolerate a higher tin content with higher lead content; but since from the point of view of casting one was partly restricted to 70/30 or 65/35, there was great advantage in keeping the tin content low.

As to segregation in centrifugal castings, Mr. Forrester suggested that one required a copper "strike" on the steel shell. In an alloy which was

mixed in the first place there was always some danger of lead forming on the shell, whereas by "striking" copper on to the steel, that tendency was reduced.

Jet-engine Bearings

MR. HOLLIGAN, dealing with the question as to the proportion of aircraft engines in this country and others which used copper/lead bearings as compared with bearings of other materials, particularly Babbitt, said it was largely a matter of bearing loads. There were many aircraft engines in use in this country in which white-metal-lined bearings were used satisfactorily. On the other hand, just as in Diesel engines and others, bearing loads in aircraft engines had increased. There were many aircraft engines using copper/lead-lined bearings, where the bearing loadings were beyond the capacity of white-metal. He did not know the relative proportions, however.

As to the application of copper/lead bearings to jet engines, he said that in general the radial loadings on jet-engine bearings were very light indeed; thus, other conditions permitting, white-metal-lined bearings were fully suitable. White-metal bearings were recommended whenever the loading conditions permitted, by reason of the tolerances, and so on. So that, provided the over-riding temperature conditions permitted, the very high surface speeds which were common in bearings made the use of white-metal-lined bearings desirable, rather than the high strength and higher frictional materials such as copper/lead. However, there were cases in connection with the gas turbine where white-metal-lined bearings had been eliminated in favour of copper/lead or other materials, mainly because of the high temperature arising in the bearings along the shafts.

Fatigue Strength

MR. CARTLAND, who commented on the difficulty of obtaining reliable information on the fatigue strength of copper/lead bearings, said that when one considered the low fatigue strength of lead—about 0.18 lb. per sq. in. at room temperature—if in a copper/lead bearing there were continuous films of lead, it seemed surprising that it should have a higher fatigue limit at any temperature below the melting point of lead.

Discussing the solubility of tin in copper and in lead, he said he understood that Mr. Holligan, in his first question, had had in mind the high solubility of tin in lead and its high solubility in copper, and had felt that there was no reason why it should not be divided approximately equally. The important point was as to compound formation; thermodynamically, the compound should form first. It was well known that tin was then soluble in the copper and insoluble in the lead.

MR. FORRESTER replied that to his knowledge there had been very few tests on the fatigue strength of copper/lead; but such brief experiments as he personally had made suggested that at operating temperatures of around 150 deg. C. the fatigue strength was of the order of twice that of low-lead tin-base alloys. On the theoretical aspects, he said copper/lead alloys commonly used had a continuous copper matrix. Lead, in addition to having low fatigue strength, had a very low value for Young's modulus, which meant that the lead could not be strained much. Thus, the copper was bound to take most of the load; the strength was determined almost entirely by the degree of copper continuity, and there was no danger of cracks developing in the lead, because it just could not be strained.

He believed Mr. Liddiard had done a great deal of work which would throw light on Mr. Holligan's previous question concerning relative solubilities. Mr. Forrester was not sure, however, that there was compound formation at the temperature at which the alloy passed from liquid to solid; there was a "tendency" to compound formation, but he was not sure that it was the same thing.

MR. LIDDIARD added that the more usual failures in white-metal bearings were due to fatigue, whereas copper/lead bearings very rarely failed from fatigue. That was a practical indication of the difference between the two.

Alternative Materials

DR. CHUBB said it was known from published work that lead had not the lowest coefficient of friction that could be achieved. He wondered, therefore, whether other materials had been tried as substitutes for lead.

MR. FORRESTER, having ascertained that Dr. Chubb was referring to non-metals rather than metals, said that graphite had been incorporated in white-metal and in bronze, especially in German practice, and he believed that quite a lot of work had been done in that connection. He pointed out, however, that a non-metal influenced only the "dry" coefficient of friction, whereas the bearings discussed in the Paper were lubricated; therefore, the effect of including a non-metal was pretty well zero. He did not think that any great success had been claimed for engine bearings having in them graphite or similar types of non-metallic lubricants.

Differential Contraction

MR. LEVY suggested that the Authors had lost sight of the contraction factor as applied to the two metals under consideration. The normal casting contraction allowed on patterns for casting either copper or lead separately was 1 in 48, *i.e.*, ¼-in. in 1-ft. But an important problem arose when trying to obtain a bond between those two metals and a third metal, as when bonding a copper/lead lining on to a steel sleeve; unless there were actual fusion of the copper/lead on to the steel sleeve, he failed to see how very good bonding could be achieved, since one was concerned with very large contraction ratios.

He understood that the Germans introduced a larger proportion of tin into copper/lead than had been attempted in this country, and he suggested that that was because tin had a very low contraction factor, practically nil; it was used as an emergency metal for producing metal patterns, where a big contraction factor would not be permissible. He assumed, therefore, that the intro-

Some Casting Problems of Copper/Lead Alloys

duction of tin would reduce the contraction allowance of ¼ in. per ft. when attempting to cast a copper/lead lining on to a steel outer shell.

MR. LIDDIARD agreed that the differential contraction as between copper/lead and steel could certainly constitute a problem. Most methods of bonding copper/lead linings to steel, however, involved a certain amount of directional cooling. One attempted usually to cool from the steel. One also endeavoured to avoid getting lead to the bond, because lead would probably give a weak bond; it was preferable to get the copper to the bond. The difference between the coefficients of expansion or contraction of steel and copper was not so great as between those of steel and copper/lead. He had mentioned linear the coefficient for lead as being around 29×10^{-6} or 30×10^{-6}, whereas that for copper was in the region of 16×10^{-6}, and the figure for steel was somewhat lower. So that, provided one could get the copper to the bond, there should not be trouble arising from differential contraction.

It seemed to have been indicated by Mr. Levy that he would not expect fusion between the copper and the steel. The degree of adhesion achieved when casting copper/lead on to steel was such that certainly some form of chemical bonding to the steel occurred—not merely a mechanical bonding—and one could certainly describe it as a fusion. Tin was added to some alloys in this country to the extent of about 2 per cent., which proportion was rather similar to those given in German specifications. The tin was present in the copper phase. In other words, one was dealing with about 6 per cent. of tin in a bronze; the difference was being considered between the contraction of a low-tin bronze and that of a copper, which were similar. In that connection, Mr. Liddiard called attention to a point made in the Paper, that adhesion was certainly not the troublesome problem in copper/lead bearings.

Segregation

MR. HONEYCOMBE discussed two points which he and his colleagues had encountered during the war in connection with some of the problems mentioned in the Paper. The first point was the effect of tin in copper/lead alloys—the segregation of the lead. They had decided to study the matter more or less fundamentally. Charges of a copper/lead/tin alloy were melted in steel cylinders, the tin content being varied. The cylinders were heated to about 1,200 deg. C. and then quenched. There was no attempt to stir or mix the lead in any way; they had depended on the fusing to produce miscibility, and they had obtained the worst possible conditions in that way. After quenching, the casts were sectioned and examined. He then showed photomicrographs of a 4 per cent. tin alloy quenched at different temperatures. When quenched at 1,100 deg. C. the tin had not really started to go into solution; at 1,200 deg. C. the tin solution had commenced and at 1,300 deg. C. the result was much more satisfactory. In practice, he added, better diffusion was achieved because the metal was vigorously stirred, particularly through the oxidation process.

Another method of investigating the matter was to cast bearings in the normal way and then to subject the metal to chemical analysis. That indicated that, as the tin content was increased, the amount of lead which could be brought into solution and precipitated became less. Mr. Honeycombe then illustrated a set of analyses of cast bearings containing different proportions of tin. Nominally the alloy in each case contained 25 per cent. of lead, but the proportion of tin was increased from ¼ to 12 per cent., and beyond. As the tin content was increased, the lead content was reduced as follows:—

Tin Content. per cent.	Lead Content. per cent.
¼	25
1	About 25
2	25
4	24
9	16
15	11

The alloys, he said, were cast in the normal commercial manner. The results indicated, for instance, that an alloy with a tin content of 9 per cent. could not hold more than 16 per cent. of lead in a suitable distribution. What happened to the rest? If it was in the form of unmixed globules, which had not gone into solution at the high temperature, the lead could be very coarsely segregated. On the other hand, the addition of tin could reduce that segregation which was caused when the lead was precipitated during cooling. Mr. Honeycombe showed further photomicrographs of alloys to illustrate the effect of varying amounts of tin in refining the lead structure. With ¼ per cent. and with 1 per cent. of tin, the lead structure was very coarse and stringy; with 2 per cent. of tin the distribution of lead was much finer; at 4 per cent. of tin the lead was globular and quite fine; at 9 per cent. of tin the lead distribution was very fine, but much less lead than formerly could be taken into solution and precipitated. With very high tin content, he continued, the second tin phase came in, and much less lead was taken into solution. On the other hand, silver had the reverse effect, *i.e.*, more lead could be taken into solution at high temperatures. One could produce copper/lead alloys containing 40/50 per cent. of lead if there were sufficient silver there.

Bonding

Referring to bonding, he said it was right to produce a good bond between a copper/lead alloy and steel. Occasionally, however, the phosphorus content became quite high, through carelessness on the part of the operators, and the effect on the bond was astonishing. He illustrated a normal bond between a copper/lead alloy and steel, where the phosphorus content was 0.09 per cent. If the phosphorus were increased to 0.5 per cent.—which was never the case in practice—there was a very thick layer of very brittle material; one could see the cracks in it, although it had not been subjected to heavy mechanical work. Such a layer also existed when using alloys containing more than 0.1 per cent. phosphorus. That was much higher than the normal phosphorus content of an alloy, but it was possible

for that amount to be present by accident, or sometimes as the result of trying to get rid of all gas, due to the mistaken impression that the more phosphorus present in an alloy, the less was the gas content.

It was in the Cavendish Laboratory that the frictional properties of the alloys were first studied. Dr. Taylor and his colleagues found that the non-dendritic alloys had frictional properties different from those of the dendritic alloys; on the other hand, the exhaustion of the lead in the non-dendritic alloys occurred earlier at high temperatures. The breakdown of the film lubrication occurred earlier in the alloys with the " plum-pudding " type of structure. It was interesting to note the effect of machining the alloys. The chips from the copper/lead were not reddish, but grey, and it was quite easy to show that that greyness was due to a very thin lead film; in a solution which would dissolve lead, one could take off that very thin film. That was an indication that the lead film really did occur in practice.

Quenching in Molten Metal

Discussing a process which had been found to be very good for casting copper/lead alloys containing tin, he said that such an alloy could be described, up to a point, as hot-short. It had a great tendency to crack when quenched by a water spray, and there was great difficulty in overcoming the cracking, which was undesirable, of course, in aircraft-engine bearings. They had tried to overcome it by quenching the parts containing the alloy, not in water, but in molten aluminium or molten lead, the idea being that all they needed to do was to solidify the copper, for the lead would look after itself. That method had worked quite well; for example, the alloy would be poured at 1,250 deg. C. into a pot at 1,000 deg. C., and then the pot assembly would be quenched in molten aluminium at 600 deg. C. It was an extremely rapid quench, but it only went half-way, and the metal did not crack. Subsequently it could be air-cooled or water-cooled. That was a means of overcoming some of the difficulties which occurred in the casting of aircraft-engine bearings.

MR. FORRESTER said the Authors had followed Mr. Honeycombe's work with great interest and had derived very considerable help from it; most of the points he had raised were certainly shown up in copper/lead casting practice. Commenting on the point that the chips produced in the machining of copper/lead were grey, he said it was rather strange that copper/lead, or for that matter a lead-bronze containing as much as 5 per cent. tin and as little as 20 per cent. lead, which had the " currant-bun " structure, would fracture grey as well as machine grey. He was quite unable to explain it. He confirmed that the grey layer could occur at the bond when using copper/lead with phosphorus contents much higher than were normal in practice, and he asked whether Mr. Honeycombe had any evidence as to the exact nature of that layer, whether it was just iron phosphide or a copper/iron phosphide.

MR. HONEYCOMBE replied that he and his colleagues had not made detailed analyses, but there was evidence of a very high nickel content. The phosphorus content was high, of the order of 1 or 2 per cent., showing that the phosphorus was causing the damage; but as to the nature of it, he could only guess.

Vote of Thanks

MR. EVANS, proposing a vote of thanks to the Authors for their Paper, also took the opportunity to thank the London branch of the Institute of British Foundrymen for having invited the members of the Institute of Metals to the meeting.

The subject, it would be agreed, was very difficult. In the first place, it concerned bearings, and nobody ever seemed to recommend any method of testing; indeed, it had been said that there were as many methods of testing bearings as there were people interested in the problem, and it seemed that there was never satisfactory agreement as to the most satisfactory bearing alloy for a given service. That had been fairly well borne out by the paper, which showed, for example, that there was disagreement between the various manufacturers as to whether the tin content was beneficial or not. He had always believed, from what he had read, that one of the advantages of a copper/lead bearing was its high conductivity and the ability to disperse hot spots, and so on, and he always considered it undesirable to reduce the conductivity of the alloy by the addition of tin. Mr. Liddiard had stated that it was only a relative matter; but, taking the conductivity of copper as 100, the addition of 4 or 5 per cent. of tin would reduce the conductivity to only about 15 or 16 per cent., which seemed to him to be a very considerable reduction. However, it was all dependent on the answer to the question as to whether one really wanted a high-conductivity bearing; and that was one of the matters which seemed never to have been definitely decided. Arising out of that apparent indecision as to what was a desirable alloy for bearings, there seemed to be many methods of manufacture. That suggested that a lot still remained to be learned about the copper/lead bearing business.

The Paper was an excellent review of all the factors in relation to composition as well as the methods of manufacture. One could not think of all the various modifications of the methods, but the Authors had reviewed the principal ones.

MR. HOLLIGAN, who endorsed the expression of thanks to the Authors, took the opportunity to revert to his own earlier remarks on thermal conductivity, for he felt that he might inadvertently have created rather a false impression. He did not say that thermal conductivity was not important; he had merely said that its effect was over-emphasized. It should be remembered that there were millions of lead/bronze linings in operation having tin contents of 4 and 5 per cent., and under the particular operating conditions applying, those linings were satisfactory. The question was one of degree.

[The vote of thanks to the Authors for their paper was heartily accorded.]

Cleaning Room Extension Opposed

Halesowen Council's refusal to allow the building of a shop for cleaning iron castings at present carried on in Ladysmith Road, Cradley, was the subject of a Ministry of Housing and Local Government inquiry at Halesowen recently. Conducting his own case, Mr. J. Bloomer, of Joseph Bloomer & Company, said that after a recent visit, a Factory Inspector drew attention to the lack of washing facilities and cloak-room space for cleaning castings. A portion of the castings they made were fragile and had to be brushed. The sand used in this operation was at present brushed into the atmosphere and the installation of a dust extractor would reduce inconvenience to residents. The alternative accommodation suggested by the Council in Park Road, Cradley, was not acceptable because it would mean the transfer of the whole business. He could not understand how washing of hands and drying of clothes would interfere with the amenities of the district. Answering Mr. E. A. Waldron, representing 12 residents in the vicinity of the foundry, Mr. Bloomer denied the casting building constituted a nuisance, nor did he agree that on working days people living near were unable to hang out their washing and had to keep their windows closed. Mr. M. W. Claye, deputy town clerk, said the Council's objection was that the site would be required for housing. The Inspector intimated that he would visit the site and closed the inquiry.

Biennial B.I.F. ?

When he spoke at the official luncheon on May 8 of the B.I.F. at Castle Bromwich, Mr. H. E. Jackson, vice-president of the British Non-Ferrous Metals Federation, made the plea that the Fair should be held only once every two years, instead of annually, because it made a big drain on exhibitors from year to year, and in the interests of the Federation he suggested such an action, pointing out that he was speaking for the " poor, down-trodden, hard-worked people who had to prepare the stands every year and face up to the expense of preparing them."

The non-ferrous industry had been bedevilled for the past three or four years by the shortage of materials. If the industry was to meet essential home needs and also undertake rearmament work, he thought it should have some voice in deciding where it should send its exports. At present the industry was not even allowed to do that. Often, after it has had the difficulty of obtaining export licences for a number of countries, it was told conversion values were not high enough. It was also finding that the Germans and Japanese were getting into the countries to which they should be exporting.

Pelsall Foundry Centenary

It is just 100 years since Pelsall Foundry was founded by Joseph Wilkes of Pelsall, and it has been in the family ever since, for three generations. It was managed for 50 years by the late Mr. Ernest Wilkes, who was a magistrate, and afterwards by his son, Mr. Arthur E. Wilkes, who died five years ago. The foundry then passed to his nephew, Mr. J. Turner, the present owner. Three generations of some Pelsall families have been employed at the foundry. The main products are colliery winding gear, brickworks plants, and iron- and brass-foundry work. The pedestal of the clock on the Bridge, Walsall, was made there. The name of the firm is now Ernest Wilkes, Limited.

Leaders of the Industry

MR. W. R. MARSLAND

Mr. W. R. Marsland, who was recently elected president of the Association of Bronze and Brass Founders, was educated at Bourne College, Birmingham, after which he served two years articled to the late Mr. F. H. Alcock, F.R.I.C., Ph.D., industrial analyst, of Birmingham. This was followed by attendance at the University of Birmingham, where he carried out research with the late Prof. P. F. Frankland. His education was interrupted by the first world war, during which he was awarded the Military Medal.

In 1932, after experience in various foundries in the North and Midlands, he joined the staff of Newman, Hender & Company, Limited, Woodchester, Glos, sharing responsibilities for the foundries with Mr. N. P. Newman. Whilst with Newman, Hender, extensions to the foundries have taken place on four occasions, and at the present time output is at least ten times greater as a result. When Mr. N. P. Newman became managing director of the Company, Mr. Marsland assumed further responsibilities in connection with the foundries.

A good deal of his time is now taken up with the activities of various associations. He is a member of the Institute of British Foundrymen, and was on the Council of the Midland Ironfounders' Association. Two years ago he became vice-president of the A.B.B.F., and this year assumed high office. In January, 1946, he accompanied Mr. R. C. Shepherd on a government-sponsored visit to German grey-iron foundries, and in January, 1950, was a member of the grey-iron founders' Productivity Team which went to the United States. At present he is very busy as chairman of the A.B.B.F. committee which is arranging the conference at Harrogate next month on Brassfounding Productivity.

" C " Process

According to the American daily press, the shell-moulding process has created much interest at the International Foundry Exhibition at Atlantic City. Three firms are showing this method:—The Borden Company, the Monsanto Chemical Company, and the Bakelite Company. Among the larger firms said to have adopted the process are General Motors, Ford, and Cooper Alloys.

Leonardo da Vinci

Harbinger of Modern Science and Engineering

By H. J. Booth

Every generation produces its own crop of geniuses; those who within their own particular spheres of activity—be it a science or an art—display far greater gifts than their contemporaries. At much rarer intervals there arises among men a person whose genius is not confined within any narrow limits, and whose mind and spirit wander with confidence through the realms of art, science, and philosophy. Such men stand out as focal points in history; embracing and absorbing art and science; giving it a new integration; and, with uncanny foresight and tremendous force, impressing their spirit on later generations with ever widening influence.

By far the greatest of these intellectual giants was Leonardo da Vinci, the quincentenary of whose birth was celebrated last month. His personality has always had a peculiar attraction for engineers, because his scientific genius sought to express itself in practical channels; and in his own day he was as much a professional engineer as a painter.

History records no other man with so many outstanding gifts; he was a painter, architect, sculptor, anatomist, physicist, and philosopher, as well as a civil, mechanical, and military engineer. Born in the early days of the Renaissance, he was one of the first to rediscover and apply the scientific method.

Early Day-dreaming

The illegitimate child of a young peasant girl by a Florentine lawyer, Leonardo was born in Vinci on April 15, 1452. At an early age he showed a marked aptitude for many pursuits, but especially for music, drawing, modelling, and—characteristically, it seems—for day-dreaming. About 1470, his father showed some of the youth's drawings to Verrocchio of Florence, who, recognizing their merit, took Leonardo as a pupil in his studio. Verrocchio himself was a man of parts, being a teacher and a first-rate craftsman in many arts of which his gifted pupil was destined to become a master.

From 1477, Leonardo began to work as an independent artist in the court of Florence. His inexhaustible intellectual capacity and curiosity were already developing, and he began to inquire into every then known branch of pure and applied science, of some of which he was to prove a pioneer. He eagerly sought the manuscript works of Archimedes—that early great man of science—whose work in hydrostatics he recovered. Leonardo's mind was full of theories, ideas, and mechanical projects, with which he started to fill his celebrated notebooks. From painting and sculpture he was led to study anatomy and physics.

It is perhaps pointless to consider whether he was foremost an artist or a man of science, for his harmonious personality transcended such distinctions, and he was instinctively a lover and a student of nature. It has, however, been suggested that all Lenoardo achieved in painting, sculpture, and architecture, was merely a concession to the age in which he lived, and that his life was devoted to one end only—the knowledge and mastery of Nature.

Military Devices

When he was about 30, Leonardo joined the court of the Duke of Milan, where he served as musician, plumber, painter, sculptor, architect, and as military and civil engineer. He was engaged on various projects concerning the canals and irrigation works of the state; and at this time he claimed to have invented many devices of a military character, such as portable bridges, pumps to drain the moats of castles, an armoured car (forerunner of the tank), and an assortment of ballistic devices. Some of his military inventions were not to achieve their natural development till the 20th century.

Circumstances forced him to leave Milan in 1499, and he subsequently wandered to the courts of Florence, Milan again, and Rome, working as an artist and an engineer. For a short period around 1502 he served as chief engineer to Cesare Borgia. His last few years were spent in France, where he went in 1516 as the servant and friend of Francis I. He died near Amboise on May 2, 1519.

As a painter, he worked slowly and produced little. There are only a few of his paintings extant (including the "Last Supper" and the "Mona Lisa"). There are, however, still in existence many beautiful sketches, and hundreds of fine engineering and scientific drawings. In his own age and for long afterwards Leonardo was renowned chiefly for his artistic work. The manuscript note-books which he left became dispersed after his death and many have probably been lost. For the most part, they remained unheeded except for his treatise on painting. It was not until his manuscripts were eventually edited and published in the latter half of the 19th century that it became generally realized how great a scientist he was. It appears that he had partly anticipated the work of Bacon in scientific method, Galileo and Newton in dynamics, and Harvey in the mechanism of the heart. The editing of his notebooks was a difficult task, for they were partly in cypher, and he had a curious habit of writing from right to left, probably due to his being left-handed.

Scientist and Engineer

His knowledge of scientific and engineering principles was truly amazing. He had grasped the principle of inertia, and recognized the futility of seeking perpetual motion as a source of power. As a

Leonardo da Vinci

physicist he dealt with waves in air and the laws of sound. He studied the properties of light and invented the camera obscura, pointing out its similarity to the function of the eye. He also anticipated the wave theory of light, and it is said that he even considered the atomic theory of matter.

He foresaw the steam age, and devised a gun in which the expansion of steam was used to project a cannon-ball. He was conversant with hydrodynamics and designed a diving-bell and a swimming-belt. Among his many sketches of mechanical contrivances have been found pumps driven by rocking beams, lifting screws, a boring machine with screw-feed and adjustable chuck, trains of gears, and spinning machines.

He concerned himself with the problems of flight and experimented without success with various designs of flying machine: he even made a model helicopter. He came to appreciate the mechanical properties of air and realized the difficulties to be overcome. He invented an anemometer, and designed a practical parachute, though there is no evidence to suggest that he actually constructed a model.

Civil Engineering

As a military engineer, he was the prototype of the modern back-room boy. He could cast multi-barrel cannons and invented a breach-loading mechanism; he also designed different types of shell and a hand grenade. As a civil engineer he carried out hydraulic projects, and even planned a canal with huge locks for raising and lowering ships (the locks used in the Panama Canal are known as da Vinci locks). He drew up schemes for two-level traffic highways and for transporting buildings across cities, and he dreamt of driving tunnels through mountains. He designed and built wooden trusses for roofs and bridges. He was probably the first to investigate experimentally the behaviour of pillars and beams under stress. His conclusions may not always agree with those of modern stress analysis, but considering the conditions under which he worked they are remarkable.

For all his genius, most of Leonardo's work in mechanics, dynamics, anatomy, and geology remained hidden in his notebooks and did not flood the main stream of scientific progress. Nevertheless, it is clear that his work embodied the quintessence of scientific and technological achievement for the next 400 years. Indeed, his career gives rise to much speculation. For instance, would the history of science have been fundamentally altered had his work been widely disseminated in his own age and met with appreciative readers? Despite the non-publication of his scientific manuscripts, how far did he actually influence the remarkable work of such men as Galileo, Ramelli and Castelli? Or, to what extent were his ideas due to earlier or contemporary workers of whom we have no record; and what were the contents of his lost manuscripts? We can only wonder what Leonardo himself might have achieved in practice with an efficient source of power and a few modern techniques at his disposal.

Yet, despite his intense activities, his popularity and charm of presence, Leonardo must have been a lonely soul; for there was no contemporary who could measure up to his enormous intellectual capacities. For the same reason it has been difficult for ordinarily endowed mortals to understand and circumscribe his genius. Havelock Ellis, whose spirit was cast in a similar mould to that of Leonardo's, has given us a clue when he wrote of him ". . . he saw every problem in the world as in the wide sense a problem in engineering. All nature was a dynamic process of forces beautifully effecting work, and it is this, as it were, distinctive vision of the world as a whole which seems to give Leonardo that marvellous flair for detecting vital mechanism in every field."

Engineers can appreciate his technological genius; critics can appraise his artistic genius; Freud can amuse himself by psycho-analysing him. But in the end we can only stand off and view this stupendous personality with awe.

Now, when the world sets out to honour Leonardo's universal genius, engineers can pay their own tribute to their distant precursor, with the knowledge that were he to return among them to-day he would soon find himself at home in their society, their drawing offices, and their laboratories. Or would he, perhaps, take it all for granted and continue in his own restless way on that endless quest to achieve the complete knowledge and mastery of Nature?

Manganese Recovery from Slag

A process developed by the U.S. Bureau of Mines at the Central Experimental Station, Pittsburgh, Pa., enables an iron-manganese mixture containing 12 to 24 per cent. Mn to be recovered from open-hearth slags. The process was described by R. C Buehl in *Iron Age* recently.

Metal from an experimental blast furnace is blown in a basic-lined converter producing a high-manganese slag that can be used as a synthetic ore. The side-blown basic-lined converter employed is capable of holding 600 lb. of metal, slags produced containing Mn 56 to 63 per cent., Fe 2 to 6 per cent., SiO_2 5 to 20 per cent., Al_2O_3 3 per cent., and P 0.01 to 0.3 per cent. The major problem is the control of the phosphorus content of the slags, a special blowing procedure having to be devised to obtain slags of satisfactory low phosphorus content. The rate of blowing and length of blowing period must be carefully regulated to selectively oxidize manganese and leave the iron and phosphorus as metal. From 4 to 6 tons of high-phosphorus metal are produced per ton of manganese in the converter slag which, at present prices, is worth several times the high-manganese slag. Such metal, states the author, probably would be given a further blow in a basic converter, lime being added to remove phosphorus.

A PROCESS for scouring both sides of steep strip simultaneously with progressively-fed coated abrasive paper is said to be gaining favour in the United States. It ensures a uniform surface over the entire length and width of the strip. Its principal application is to remove pickle etch and superficial imperfections from stainless strip before bright rolling.

Note on the Deoxidation of Brasses*

It is frequently thought that the deoxidation of brasses should be carried out by the use of phosphor-copper, as is the case with bronzes. However, the existing scarcity of phosphor-copper compels the founder to turn to other deoxidants, such as silicon-copper; cupro-manganese, or cupro-aluminium. The Author's opinion is that the deoxidation of brasses by an alloy addition is of little interest except for brasses containing a copper content of at least 80 per cent. copper. For brasses of the first or second order, the natural deoxidant is zinc added at the end of the melting.

Nevertheless, however, there could be envisaged the practice of systematic additions of certain elements, and in this case it is necessary to prepare special alloys. It is thus of interest to know what percentage of phosphorus, aluminium and silicon can remain, and what will pass into the slag.†

Silicon additions were invariably made for the purpose of these tests in the form of either 10 or 25 per cent. cupro-silicon so as to obtain the following nominal contents:—

0.20 per cent. as a single addition;
0.50 per cent. as two successive additions;
0.50 per cent. as a single addition.

The master alloy was added in the furnace five minutes before casting and briskly stirred immediately after introduction, the melting always being conducted under a layer of charcoal. When making two successive additions, it is necessary to wait until after the first quantity of cupro-silicon has done its work and some metal cast into a ladle, a second addition is then made in the furnace under the same conditions as the first.

(*a*) The silicon contents were invariably higher when utilizing pure metals than when use was made of refined ingots of the same nominal composition, as is shown in Tables I and II.

(*b*) In the presence of phosphorus, the silicon contents are not necessarily higher than when silicon alone is added. This is shown in Table III.

From Table III it is clear that SP 4 range gives higher silicon contents than the S 2 range, but it is necessary to take into consideration that the addition of SP 4 has been made as one single operation, and not double operation as was the case with the S 2 range.

(*c*) In the presence of aluminium, a contrary effect is noticed, and the silicon contents appear to be slightly increased (see Table IV). In any case, the fact that under good conditions a yield of 95 to 100 per cent. of silicon can be obtained shows that either this element has no noteworthy deoxidizing influence, or that the zinc suffices for protection during the melting process, the latter being effected under charcoal.

TABLE I.—*Effect of Adding 0.20 per cent. Silicon Compounded from Pure and Secondary Metals.*

Test.	Percentage silicon obtained.	
	Pure metals.	Ordinary metals.
S 1	0.19	0.12
S 1	0.15	0.17
SP 1	0.22	0.09
SP 1	0.20	0.11
SP 2	0.18	0.09
SP 2	0.18	0.15
AS 1	0.20	0.13
AS 1	0.21	0.15

TABLE II.—*Nominal Silicon Addition 0.50 per cent.*

Test.	Percentage silicon obtained.	
	Pure metals.	Ordinary metals.
S 2	0.47	0.31
S 2	0.30	0.28
SP 3	0.50	0.38
SP 3	0.54	0.32
SP 4	0.47	0.38
SP 4	0.51	0.33
AS 2	0.49	0.37
AS 2	0.45	0.32

TABLE III.—*Influence of Phosphorus on Silicon Additions.*

Phosphorus present.		Phosphorus absent.	
0.20 per cent. Si.	0.50 per cent. Si.	0.20 per cent. Si.	0.50 per cent. Si.
SP 1	SP 4	S 1	S 2
0.22	0.47	0.19	0.47
0.09	0.38	0.12	0.31
0.20	0.51	0.15	0.30
0.11	0.33	0.17	0.28

TABLE IV.—*Influence of Aluminium on Silicon Additions.*

Aluminium present.		Aluminium absent.	
0.20 per cent. Si.	0.50 per cent. Si.	0.20 per cent. Si.	0.50 per cent. Si.
AS 1	AS 2	S 1	S 2
0.20	0.49	0.19	0.47
0.13	0.37	0.12	0.31
0.21	0.45	0.15	0.30
0.15	0.42	0.17	0.28

Phosphorus additions have in every case been made as 15 per cent. phosphor-copper, so as to obtain between 0.05 and 0.15 per cent. P., following the same principles as for the silicon additions. It is not difficult to draw conclusions as to the effectiveness of the quantities added, from the fact of the low order of the contents studied. For a nominal addition of 0.05 per cent., it is usual to find the final content of 0.03 per cent. as a minimum. For 0.15 per cent. of P in two successive additions, the extreme figures found are between 0.10 and 0.14 per cent. It should be noted that the highest figures are those where the additions were made in the presence of silicon, the melt always being carried out under charcoal. Finally, there is confirmation that the residual contents of phosphorus are generally less than the residual contents of silicon, the fraction eliminated by combustion with air being more important.

* Translated from the February, 1952, edition of *Fonderie*.

† Contribution to the Study of Foundry Brasses by Mr. Cirou and Mr. P. J. Le Thomas, *Fonderie*, No. 71, December, 1951, pages 2751-2758.

Synthetic Resins in the John Harper Foundry

(*Continued from page* 539)

U.F-resin binders. There are, however, many examples where an increased rate of production has been made possible. With 40 per cent. of the coreshop jobs now being made in synthetic-resin sand, the total production of cores from the shop has increased by about 10 per cent.

Due to the excellent "breakdown" properties of U.F-resin cores, it was felt that cores which were surrounded by heavy sections of metal, which would have an extended cooling time, might disintegrate prematurely, that is before the casting had solidified, and that consequently the core shape would be lost. This fear was not altogether unjustified as some examples have shown. It is therefore obvious that the ratio of metal section to core thickness is critical, with the mixtures so far employed, and care has to be exercised where a small core is enclosed by a fairly-heavy metal section which will involve delayed solidification. Work on this aspect is being continued, employing examples requiring larger cores for larger and thicker section castings. In all cases, so far, a better skin finish is obtained.

Economic Aspects

The economic possibilities of resin-bonded cores can probably be best demonstrated by giving the actual cost of the urea-formaldehyde resin mix and of the linseed-oil mix which it has replaced. These costs are worked out on prices of 12 months ago but are still relative, viz.

Linseed-oil mixture.—Consisting of 380 lb. dried silica sand; 20 lb. red sand; 8 lb. dextrin; 3 pints linseed-oil and 1 pint proprietory core-compound, total raw material cost: 13s. 0d.

U.F. resin mix.—380 lb. dried silica sand; 20 lb. red sand; 5 lb. dextrin; 4 pints U.F. resin and 25 ml. wetting agent, total raw material cost: 8s. 11d.

The U.F. resin mix therefore shows in this case, a saving of 4s. 1d. per mix. In addition to this, of course, there must be added, the saving of fuel due to the lower temperature and increased speed at which the drying stove can be operated, as well as the reduced labour charges on the knock-out and in the fettling shop.

Conclusions

Enough has been written in this Paper to demonstrate that resin binders can offer exceptional advantages and that urea-formaldehyde resins seem to show the greater promise. Much development work has been necessary to produce a core-mix which could be satisfactorily worked in the coreshop and which would also produce a really good core for delivery to the foundry. A greater degree of control and care is necessary than for oil-bonded core practice; but provided attention is paid to all the points discussed, the advantages that have been described can be obtained, and synthetic resins will be introduced into the foundry without undue trouble. Work still remains to be done on the maximum size and weight of core which can be successfully made, bearing in mind the section and weight of the metal in the casting. Finally, knowing that resin bonded cores lend themselves to high-frequency di-electric curing, the foundry that is already in production with resin-bonded cores, will be in a very favourable condition to take advantage of any development in this direction on a production basis.

The Authors acknowledge the permission given by the management of John Harper & Company, Limited, for the preparation and publication of this Paper.

B.T.H. Jubilee

British Thomson-Houston, Limited, of Rugby recently celebrated its Golden Jubilee by holding a luncheon party, when Mr. E. H. Ball presided. Amongst those present were Mr. James Johnson, M.P., and the Mayor of Rugby.

The Company was formed, from the Laing, Wharton & Down Company, in May, 1896, and at that date the personnel already had ten pioneering years of electrical contracting to their credit. By 1900, the business secured by B.T.H. was rapidly outstripping the supply of equipment and the manufacturing resources available. Moreover, it appeared that the political campaign against "free trade" might lead to a tariff on imports. It was decided, therefore, that the Company must commence manufacturing on its own account, and search for a suitable locality began. The site at Rugby was attractive—being near to the Midland coal fields, adjacent to river water, and having good railway facilities. So the 25 acres of land known as "Glebe Farm" were bought for £10,000 from Thos. Hunter & Company. By the end of 1901, construction of the fourteen or so buildings was well advanced. These buildings included lamp factory, foundry, machine shop, blacksmiths, meter factory, power house, and offices. The small works at Bankside, London, closed down when manufacturing commenced at Rugby in March, 1902. As originally planned, the Rugby Works had a total floor space of 206,000 sq. ft., to give employment to about 800 operatives. The Technical and Commercial Departments at this time covered a surprisingly wide field; but actual manufacturing was for a time confined to incandescent lamps, meters and instruments, A.C. and D.C. machines, switchboards, and steam turbines.

Since the first buildings were erected, there has been a steady expansion of both manufacturing facilities and technical progress. Very considerable sums have been "ploughed back" into the business to provide more and better machine tools, measuring, and testing equipment; also to extend the original buildings, and to erect others to cope with the manufacture of an ever-growing number of products, ranging from some of the largest turbo-alternators, transformers, hydro-electric alternators, and motors, to Mazda lamps, millions of which are made annually in Rugby. Half-a-century has seen the Rugby Works increase in floor space to nearly two-and-a-quarter million sq. ft.—well over ten times the original area. During the period, thirteen other factories have been brought into production in other towns, and to-day the B.T.H. organization has a payroll exceeding 24,000.

Notes from the Branches

London—East Anglian Section

The annual general meeting of the East Anglian section of the Institute of British Foundrymen was held in the Lecture Hall, Central Library, Ipswich, on April 15, Mr. V. W. Child presiding. The annual report, presented by the secretary, Mr. L. W. Sanders, contained the following items of interest. During the past session, the section had witnessed a full technical programme of seven meetings, which had presented a diversity of subjects. The papers, with the exception of one technical session, were all presented by members of the section, the subjects being as follow:—Presidential address—" Rôle of the Metallurgical Department in Works Control "; " Core-blower Application and Operation "; films—" Great Names," by F. H. Lloyd & Company, Limited, and " Aluminium Alloy Castings," by High Duty Alloys, Limited; " Brains Trust "; " Sand Preparation and Control " (symposium); " Feeding Techniques " (symposium), and (that evening) Morris Motors' film, " Magic in Metal." A tribute was accorded the authors and various managements whose co-operation made this satisfactory programme possible. An interesting visit to Ransomes, Sims, & Jefferies, Limited, took place on June 20, and a very instructive afternoon was enjoyed by the visitors. During the session, the section held a dinner and social evening, and it was hoped that this could be made an annual event.

Membership. Membership strength of the section decreased slightly owing to several members leaving the district. Generally, the attendance at technical sessions had considerably improved, the average attendance being 35, which was roughly 40 per cent. of the total strength. It was doubtful if this percentage could be bettered by any other branch or section in the country. On the proposal of Mr. Carrick, seconded by Mr. Wincer, the report was adopted.

Election of Officers

The following officers were elected for the 1952-1953 session:—*As president*—Mr. R. J. Hart; *as senior vice-president*—Mr. H. Ward; *as junior vice-president*—Mr. C. N. Jennings; *as secretary*—Mr. L. W. Sanders; *as members of Council*—Mr. W. Cates was re-elected for three years, and Mr. P. Nice was elected for three years. Mr. Wincer was elected for two years in place of Mr. Watson, who has left the district, and Mr. K. Cutt for two years in place of Mr. Ward.

After the business meeting, a film on the coremaking and moulding of a cylinder-block was presented by courtesy of Morris Motors, Limited. The film, which outlined various aspects of the production of this type of casting, was greatly appreciated by members of the section and a vote of thanks to Morris Motors was proposed by Mr. Jennings.

Wales and Monmouth

The annual dinner of the Wales and Monmouth branch of the Institute of British Foundrymen was held at the Royal Hotel, Cardiff. Mr. Colin Gresty, president of the Institute, the Lord Mayor of Cardiff (Alderman Robert Bevan), and Mr. T. Makemson, national secretary of the Institute, were amongst the guests. Mr. Harold Davies, branch president, was in the Chair.

Mr. P. L. Gould, proposing the toast of the Trade and Commerce of the City of Cardiff, paid tribute to the traders of the city in days gone by, when it was but a village, saying " I feel sure that there are as good fish in the sea as ever there was before and if the rising generation are allowed freedom of action and are given incentive we will find rising amongst us men of a like calibre of those pioneers we have spoken of who will lead this city from strength to strength."

After the Lord Mayor of Cardiff (Alderman Robert Bevan) had replied, Professor Hugh O'Neill proposed the toast of " The Institute of British Foundrymen," and praised the way in which the Institute looked after the young men in the industry. Great progress had been made and the Institute had much to do with this progress.

Mr. Colin Gresty, national president of the Institute, responding, said the present strength of the Institute was a wonderful tribute to the small handfull of men who founded it 50 years ago.

Mr. T. Makemson, secretary of the Institute, proposing the toast of the Wales and Monmouth branch of the Institute, said the branches were the foundation of the Institute. The superstructure was built upon the provincial bodies which met in some 17 cities and towns in the country. In the Wales and Monmouth branch, there used to be 50 members. Now there were two branches in the area with a total of 350 members. He stated that South Wales was a growing foundry area and felt that the new foundries should contribute more members. There was no reason why the Wales and Monmouth branch should not be one of the larger branches in a few years.

Mr. Harold Davies, president of the branch, responding, congratulated Mr. Makemson on completing 25 years' loyal service to the Institute. Mr. R. J. Richardson proposed the toast of the visitors, and Mr. Thomas Jolly and Mrs. Rawden responded.

Steel Output Falls in April

Steel production declined last month. Output was at an annual rate of 15,866,000 tons, compared with 16,648,000 tons in March and an annual rate of 15,991,000 tons for the first quarter of the year. Production in April, 1951, was at an annual rate of 16,771,000 tons.

Production of pig-iron in April was at an annual rate of 10,472,000 tons. In the previous month the annual rate was 10,490,000 tons, that of the first quarter of the year being 10,355,000. A year ago pig-iron production was at an annual rate of 9,280,000 tons.

Production last month was affected by the Easter holidays, which last year fell in March.

Latest steel and pig-iron output figures (in tons) compare as follow with earlier returns:—

	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1952—March ..	201,700	10,490,000	320,200	16,648,000
April ..	201,400	10,472,000	305,100	15,866,000
1st quarter ..	199,100	10,355,000	307,500	15,991,000
1951—March ..	184,100	9,572,000	318,200	16,546,000
April ..	178,500	9,280,000	322,500	16,771,000
1st quarter ..	184,400	9,587,000	315,900	16,425,000

INSTALLATION OF A PIG-IRON PLANT to meet the demands of the fast-expanding engineering industry in the country is being considered by the Government of India. Announcing this in Delhi recently, Mr. N. V. Gadgil, Minister for Works, Production, and Supply, said the plant would have a capacity of 350,000 tons of pig-iron a year. This would be over and above the increased production of pig-iron by the States and the Steel Corporation of Bengal, Limited, with the active help of the Government.

I.L.O. Steel Discussions

Within the past two years, the position of the world's iron and steel industry had passed from a state verging on over-production to one of acute shortages, said Mr. Luis Alvarado, assistant director-general of the International Labour Office, at the International Labour Organization conference at Geneva. Addressing the opening sitting of the fourth session of the I.L.O.'s iron and steel committee, Mr. Alvarado said that when the committee last met in 1949 supply and demand in the steel industry seemed equally balanced. In some countries and in some sectors of production, there was even the fear of production outstripping demand. To-day, however, due to rearmament programmes in various countries, steel production had reached maximum levels, existing steel stocks seemed insufficient, and there was an acute shortage of raw materials.

Government, operator, and employer delegates from 15 iron and steel producing countries are represented on the committee, which is presided over by Mr. V. K. R. Menon, Indian Government representative on the I.L.O.'s governing body. The German Federal Republic and Japan are attending for the first time.

Forty Years Ago

In the issue of the FOUNDRY TRADE JOURNAL for May, 1912, the present Editor was quite thrilled to read that he took part in a discussion on a Paper by Professor H. C. H. Carpenter (later Sir Harold) on the growth of cast iron. There appears a very interesting article from the historical point of view on mechanical core making by Mr. H. G. Green who stated that the first core-making machine to be patented was in 1893 by Mr. F. A. Williams of Newport. It was based on a rotary bar and board for loam cores. There was also an article on the lighting of foundries when 3-ft. candles was suggested! It is recorded that the Brass Masters' Association had agreed to discounts being reduced by 2½ per cent. and net prices advanced by 5 per cent. The deaths were announced of Mr. John C. Bull—a nonagenarian inventor of the alloy bearing his name, and Mr. W. E. Hipkins, managing director of W. & T. Avery who lost his life in the Titanic disaster.

Unemployment Increases

There was little change in the size of the total working population during March. Ministry of Labour statistics show that there was a total working population of 23,443,000 at the end of the month, an increase of 13,000 on the February figure. In the metals, engineering, and vehicles group there was a decrease of about 4,000 in comparison with February, while a rise of 2,000 was recorded in the number of wage earners on colliery books. There was a decline of 57,000 in the number employed in the manufacturing industries as a whole.

The total number of persons registered as unemployed at April 21 was 467,900, of whom 142,800 were temporarily stopped. This represented an increase of 34,900 on the total at March 17. Of the latest figure, 138,400 had been unemployed for more than eight weeks. Unemployment represented 2.2 per cent. of the estimated total number of employees, compared with 2.1 per cent. in March and 1.2 per cent. in April, 1951.

Films for Paris Congress

The sixth congress of the International Scientific Film Association will take place in Paris this year from September 23 to October 1. At the congress there will be meetings of the general assembly of the International Scientific Film Association, and of the permanent committees dealing with medical, research, technical, and industrial films, as well as a festival of scientific films. A special committee of the British Scientific Film Association is to be set up to consider and recommend films for submission to the scientific film festival. This committee would be glad to have, as soon as possible, information about suitable films for this purpose. Full details of films for submission should be sent, including title, running-time gauge, date of production, brief synopsis, etc., to the Scientific Film Association, 164, Shaftesbury Avenue, London, W.C.2.

In order that this country might be properly represented, it is essential that films should be viewed in good time. Producers are asked to indicate whether they would be willing to provide copies for this purpose, and later for exhibition in Paris. The Association would also be pleased to have details of research and record films of specialized types, which need not necessarily be in the form of complete titled films, for showing at meetings of the permanent committees dealing with medical, research, technical, and industrial films.

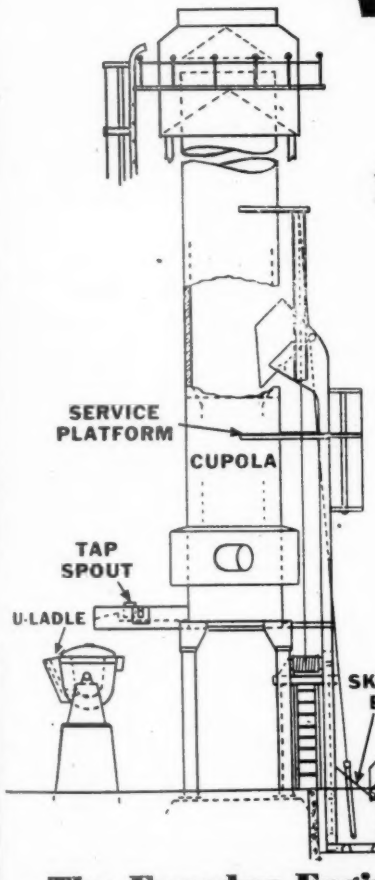
Employment in Iron Foundries

When MR. M. MACPHERSON asked the Minister of Supply, in view of the amount of short-time working in iron foundries, what steps he was taking to ensure that the resources of the industry were fully utilized, MR. SANDYS said that he was not aware that there was short-time working on any appreciable scale in the ironfoundry industry as a whole. However, he knew there were difficulties at individual foundries arising from the general shortage of raw materials and also, to some extent, from the recent cut in Commonwealth imports.

Later MR. MACPHERSON asked the President of the Board of Trade what steps he proposed to take when undertaking commercial negotiations with other countries in order to assist the light-castings industry to play its full part in the export programme, MR. H. STRAUSS said that he understood that the questioner had in mind such products as baths, and gas and electric stoves. "We are always ready to give what help we can in promoting exports of these and other goods," he said. He invited Mr. MacPherson to inform him of any special difficulties which he had in mind.

BRITISH INDUSTRIES have contributed £320,400 towards the £844,500 total cost of the Anglo-American Council on Productivity's work since it was founded in 1948, but this figure includes a grant in aid of £150,000 from the Government. To continue in this country the work of promoting higher productivity which has been started by the Council, a British Productivity Council is to be set up. This Council, expected to be in operation by the end of the year, will be composed of about 24 members appointed from industry by the British Employers' Confederation, the Federation of British Industries, and the Trades Union Congress. There are to be no further team visits to the United States at national level, but industries will be helped if they wish to send their own teams. One of the Council's first commitments may be that of a national convention on productivity in London in the autumn. To help further exchanges of information, an office may be maintained in the United States.

There is a WHITING *Scheme* for every foundry



Whiting mechanisation schemes offer tremendous opportunities for savings in foundry operation. Output is increased, operating costs reduced and working conditions are improved. Layouts—"Tailor Made" in the well known Whiting manner—are available for foundries of every size.

For the smaller foundry, a small Cupola with vertical skip hoist of the type shown is recommended. For large foundries there are multiple Cupola installations served by swivel chargers or cranes, fully equipped for the mechanised handling of all materials.

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Personal

MR. B. MILLINGTON, formerly with the International Meehanite Metal Company, London, has been appointed assistant foundry manager at the New Works foundry of the Stanton Ironworks Company, Limited, Nottingham.

MR. P. J. BOVILL, B.Sc., M.I.I.A., vice-chairman of the local Board and general manager of the chemicals branch of Newton Chambers & Company, Limited, Sheffield, is combining business with pleasure on a visit to East Africa.

VISCOUNT WEIR OF EASTWOOD was the guest at dinner last week of past and present members of club committees to mark his 50th year of membership of the Royal Scottish Automobile Club. By a coincidence the day chosen was also his 75th birthday.

MR. ANDREW SHANKS, director of Shanks & Company, Limited, sanitary engineers, Barrhead, whose father was chairman and managing director, has been elected Provost of the town. His father, Mr. William Shanks, worked to secure burgh status for Barrhead and was the first Provost.

MR. ARTHUR ARBLASTER was surprised to find himself the recipient of an award when he presented long-service diplomas and cash awards at the works of Arblaster & Company, ironfounders, of Wednesbury, on May 15. Mr. Arblaster, who 50 years ago founded the engineering firm which bears his name, received from Dr. J. E. Hurst, chairman and managing director, a cheque for £50 and a promise that his certificate would follow.

THE PRESIDENT of the Board of Trade, the Rt. Hon. Peter Thorneycroft, recently handed to MR. STANLEY HOLME the insignia of an honorary Commander of the Order of the British Empire which the Queen has been pleased to confer on him. Mr. Holme has acted as one of the joint secretaries (American side) of the Anglo-American Council on Productivity and is assistant to the chairman of the Board of the General Electric Company (U.S.A.).

MR. THOMAS SMOUT, 92-year-old father of Sir Arthur Smout, director of I.C.I. Metals Division, and president of the Birmingham Chamber of Commerce, made a tour of the British Industries Fair at Castle Bromwich on May 14. Mr. Smout made a point of visiting the I.C.I. where he said, "I was Assistant Secretary with Elliotts, a metal company, before they amalgamated with I.C.I. My son (Sir Arthur) joined the firm at 16 and has done very well."

THE BRITISH COUNCIL has arranged a programme of study for PROF. V. L. NARAYANAN, Principal of the Birla College of Engineering, Pilani, India, who is on a six weeks' visit to this country. Prof. Narayanan was appointed to found the college at Pilani in 1946 and, in addition to being its principal, he is Professor at the College of Engineering, Madras, Regional Inspector of Technical Training, Dean of the Faculty of Engineering at Rajputana University, and a member of the India Council of Technical Education.

OFFICERS of the Keighley Association of Engineers elected for the coming year are:—As *president*, Mr. J. C. Barwick; as *hon. secretary*, Mr. D. O. Rushton; as *hon. treasurer*, Mr. G. N. Smith; as *Council members*, Mr. M. Baldwin, Mr. P. Smith, Mr. W. J. Wood, Mr. P. F. Simpson, and Mr. R. S. Punt; as *hon. lanternist*, Mr. R. Shackleton; as *junior representatives*. Mr. G. Sugden and Mr. G. I. Smith; as *hon. auditors*, Mr. N. Nunweek and Mr. F. Burton. Mr. Barwick was also nominated for the presidency of the West Riding Engineering Federation.

MR. JAMES MITCHELL, chairman of Mitchell, Russell & Company, Limited, ironfounders, Bonnybridge, celebrated his golden wedding with his wife and family, when they entertained a number of friends at dinner and dance in the Royal Scottish Auto Club. Later they entertained senior staff members of the firm and their wives to dinner and theatre at the Alhambra Theatre, Glasgow. Among the many presents they received was a television set from the Company, a solid silver salver from the directors of Smith & Wellstood, Limited, ironfounders, and travelling rugs from another firm.

MR. RONALD R. HOOD, of Ayr, has been asked by Babcock & Wilcox, Limited, to go to South Africa as a member of the nucleus staff appointed to start going a new factory for the manufacture of boiler parts at Vereeniging, near Johannesburg. Mr. Hood served his apprenticeship as a marine engineer and draughtsman with the Ailsa Shipbuilding Company, Troon, and afterwards went to London, where he became contracts engineer in piping and plant layout with Babcock & Wilcox. He sails on June 26 with his wife and two children.

MR. LESLIE GAMAGE, vice-chairman and joint managing director of the General Electric Company, Limited, has been elected president of the Institute of Export for the 10th consecutive year. He joined the General Electric Company in 1919, and has served as secretary, a director, and general manager with the company. He has specialized in export, and has travelled widely, particularly within the Commonwealth. Mr. Gamage has also accepted an invitation from the President of the Board of Trade to continue as a member of the Council of Industrial Design, on which he has already served for seven years.

Obituary

MR. ARTHUR E. WILLIS, managing director of Penman Metallic Packing & Engineering Company, Limited, Gateshead-on-Tyne, has died at the age of 71. He had been associated with the Company for 50 years.

A FORMER CHAIRMAN of Thomas Andrews & Company, Limited, high-speed tool steel manufacturers, etc., of Sheffield, MR. THOMAS TROTT died on May 10 at the age of 79. He retired from the Company in 1942 after 50 years' service.

THE DEATH occurred recently of MR. JOSEPH MURTAGH, formerly managing director of Newton Steelwork Company, Limited, Burnley (Lancs). He joined the Company as office boy, and retired two years ago after 50 years' service. He was 71.

MR. ELLIS FLOWER, well known in Lancashire and Yorkshire foundry circles and a past-president of the Institute of British Foundrymen, died recently. He was a director of E. S. Lord, Limited, of Rochdale, and was associated with J. & J. Dyson, Limited, of Sheffield.

THE DEATH occurred recently of MR. BENJAMIN JAMES STEVENS, marine director of Rye-Arc, Limited, engineers, ship repairers, and boilermakers, of London, E.C.3. Aged 55, he had been associated with the shipbuilding industry on the Thames all his working life.

SIR MARTIN MELVIN, who died at his Warwickshire home on May 11 at the age of 72, was chairman, *inter alia*, of Metallisation, Limited; Charles Clifford & Son, Limited; and Ingall, Parsons, Clive & Company, Limited. A life governor of Birmingham University, he was among the Midlands' most prominent industrialists.

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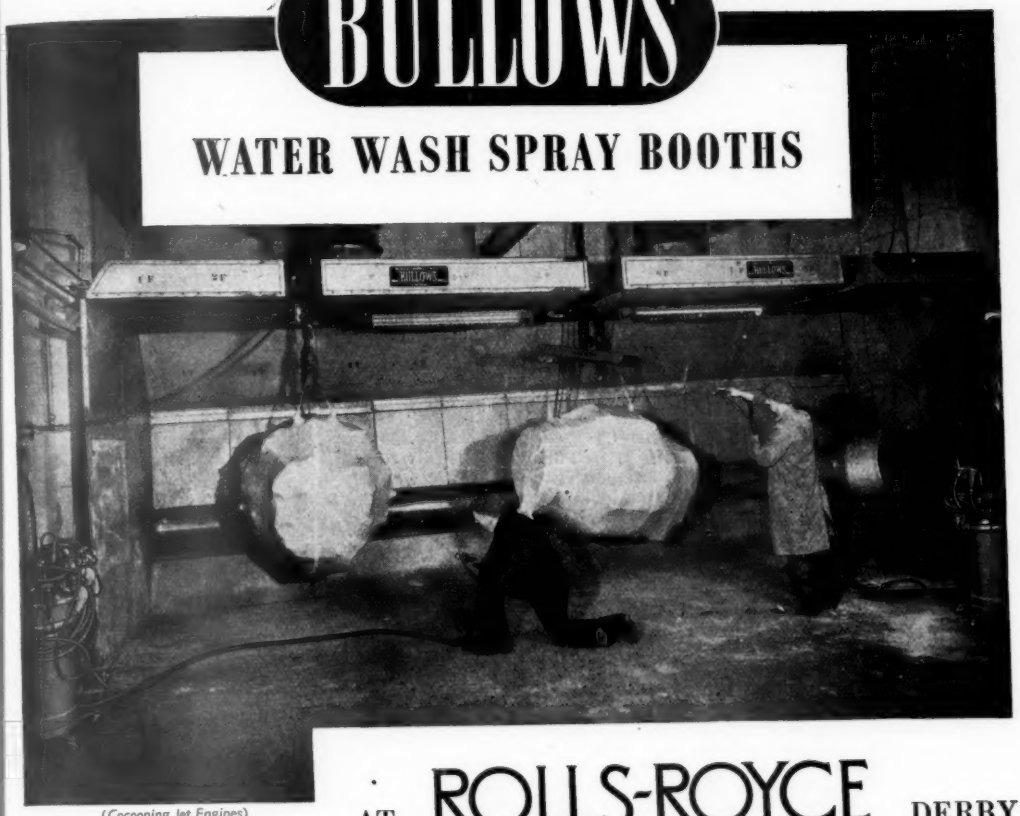

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News in Brief

MEMBERS of the Beeston Boiler Company Foremen's Association visited the British Industries Fair at Castle Bromwich, on Saturday, May 10.

AS PART of the convention held concurrently with the Mechanical Handling Exhibition, Olympia, June 4 to 12, a Paper "Foundry Mechanization" will be presented by Mr. J. Bain on June 5.

LONG SERVICE AWARDS have been received by five employees with 40 years' service and 31 with 25 years' with Henry Hope & Sons, Limited, metal window manufacturers, etc., of Smethwick (Staffs).

M. MASSIGLI, the French Ambassador, at the official luncheon of the Castle Bromwich B.I.F., urged Britain to retain the traditional quality of its goods, saying she should not "sacrifice entirely to the idol of dollar earnings and mass production."

ORDERS for two motor coasters, each of about 1,600 tons, have been placed with a Clyde firm by the Australian Government. No details have yet been announced of the builders, but the vessels are intended for the North Queensland timber trade.

A TOTAL of 310,775 tons of pig-iron, 277,162 tons of ingot steel and 183,194 tons of rolled goods was produced in Austria during the first three months of 1952. Compared to the first quarter of 1951, these figures show an increase of 32.5, 12.5 and 19 per cent. respectively.

THE ASSOCIATION OF BRONZE AND BRASS FOUNDERS announce that an informal meeting of members of the Lancashire and Cheshire area will be held at the Midland Hotel, Manchester, on May 29, 1952, commencing with luncheon at 12.30 p.m. The president, Mr. W. R. Marsland, will attend.

JOHN LEWIS & SONS, LIMITED, completed preliminary tests of their first Doxford opposed piston oil engine and began full power trials on their test bed last week. This completes the first phase of an entirely new departure for the firm—the building of high-powered Doxford marine engines.

AFTER NEGOTIATIONS lasting more than 18 months four German firms have received from the Egyptian Government an order for the construction of a steelworks at Aswan. The works, which is scheduled to be ready by 1956, will have an annual capacity of 160,000 metric tons of crude steel.

THE A.P.V. COMPANY, LIMITED, of Wandsworth Park, London, will use the processes and technical data of the Cooper Alloy Foundry Company, of Hillside, New Jersey, U.S.A., for the manufacture of stainless steel valves, the Mutual Security Agency Commission to the U.K. announced on May 15.

THE ONE-INCH SCALE prototype cruiser model which has been made by Mr. H. Brownless, chairman of Keighley Model Engineering Society, and which is a model of the highest quality and of perfect craftsmanship, is to be displayed in Barcelona from October 5 to 10 and in Madrid from November 5 to 10 at the international exhibitions of ship models being held in those cities.

FIRST PAIR of Vampire jet wings to be constructed at the works of Blackburn Aircraft Company left Dumbarton last week for England. During the war the factory employed 4,000 people and built 250 Sunderland flying-boats. After the war they switched over to the construction of aluminium houses. In addition to wings for jet fighters, other component parts for jet freighters are under construction.

TWO NEW 20,000-ton liners, specially designed for carrying troops, are to be built on the Clyde. One is to the order of the B.I. Steam Navigation Company, and the other for the Bibby Line, Limited. The latter is to be built by the Fairfield Shipbuilding & Engineering Company, Glasgow, and Barclay, Curle & Company, Limited, Glasgow, will construct the former. Both vessels will have twin-screw turbine machinery of about 18,000 s.h.p.

WORK HAS STARTED on the erection of blast-furnace plant near Sarajevo, Yugoslavia. Annual output is expected to total just over 100,000 tons thus making the new plant the second largest of its kind in the country. About one-half of the machinery needed will be made within the country, while the other half is to be imported from Sweden and Norway. The plant will obtain its raw material from nearby ore mines and it is expected that work will start at full capacity in 1954.

IN HIS ANNUAL REPORT for 1951, Mr. E. J. Dodd, Chief Constable of Birmingham, states that the large increase in the number of larcenies is attributable to the prevalence of metal stealing in the Midlands. In Birmingham last year there were 684 thefts of metal involving property valued at £18,460 of which just over £7,000 worth was recovered. It was stated that the acute shortage of metals and the extraordinarily high prices obtained for scrap metal was the reason for this type of crime.

THE METHOD OF SLAG REMOVAL employed at the Abbey Works of the Steel Company of Wales makes somewhat novel and interesting use of stud-link chain. By means of a length of chain suspended from an overhead crane the slag is pulled out from the slag pockets of the new open-hearth furnace in one piece. Formerly, the slag was cut out but this took a long time; this new method, which originated in America, is much quicker. Cast steel chain manufactured by Brown, Lenox & Company, Limited is used in this operation.

IF THE GOVERNMENT and economic conditions permitted, the British motor manufacturing industry could build 700,000 cars and 300,000 commercial vehicles a year with only 250,000 tons more steel than it used in 1950, said Mr. R. Gresham Cooke, director of the Society of Motor Manufacturers and Traders, in Sheffield on May 12. This would more than satisfy the home market and present export commitments. The industry's total steel demand would be only 8.4 per cent. of the national output of 16,000,000 tons, compared with 7 per cent. of national output before the war.

WHEN THE DUKE OF EDINBURGH finished his seven-hour tour of the Abbey and Margam works of the Steel Company of Wales, Limited, recently, he was presented with two mementos of his visit—a replica of the company's insignia, a Welsh dragon standing on two rolls of strip steel, which had been made at the works, and also a bound and inscribed copy of the special issue of the *Iron and Coal Trades Review*, entitled "A Technical Survey of the Abbey, Margam, Trostre, and Newport Plants of the Steel Company of Wales, Limited," which was published in January. The copy contained an illuminated title-page and a message from Mr. E. H. Lever, chairman of the Steel Company of Wales.

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Raw Material Markets

Iron and Steel

The quantity of imported iron ore continues to improve and with increased deliveries of native ironstones adequate tonnage is available for the furnaces now in blast, although improved outputs would be assured by an increase in the proportion of higher grade ores. This would also enable producers to supply pig-iron to analyses more in keeping with the needs of the foundries. Available supplies of blast-furnace coke diminish the prospects of an early expansion of pig-iron production as there is still a large deficiency in the supplies needed before fresh units can be blown in and sufficient quantities assured for continuous working.

Demands from both steelworks and foundries for increased supplies of pig-iron are not relaxed. The scrap drives are producing useful results, but imports are not improving.

A large proportion of the present make of pig-iron is reserved for the steelworks with a corresponding reduction in the foundry grades. Hematite on this account is in short supply for the engineering and speciality foundries which cannot obtain sufficient supplies and the low- and medium-phosphorous irons are also in short supply. The refined grades of pig iron are readily accepted and makers have no difficulty in disposing of outputs.

The light and jobbing foundries are using up all the high-phosphoric pig-iron they can obtain, and have work on hand to warrant larger supplies. Production is barely sufficient to meet current consumption.

Deliveries of foundry coke are coming forward regularly, but there is little to spare after current needs have been met.

Production of small sections, bars, and strip at the re-rollers is readily absorbed by the orders on hand from home and oversea, and outputs form only a portion of the orders on hand. Short-time working is fairly general and there is little prospect of an early improvement in the position. Deliveries of semis at present being received from oversea are small to individual re-rollers, and some mills are closed pending the arrival of sufficient steel to warrant a restart.

Non-ferrous Metals

A further reduction of 2 cents in the price of lead last week brought the U.S. quotation down to 15 cents, but at the time of writing there has not been any news of an increase in buying interest by the American consumers. On this side the Ministry of Materials brought its price down by £16 to £131, but here again users continued to cover strictly on a hand-to-mouth basis and the chances of anything like a rush are remote. At any rate, that appears to be the case at the time of writing.

But it may be doubted whether the Government will sell much lead even at £131, for there are outside interests, makers of English refined brands, who are willing to sell at a shade on the official price. The amount of lead thus available is, of course, not so very large and it is not suggested that the Ministry is unable to market any lead at all. It is a fact, however, that consumers are showing little interest at present and they are presumably still pursuing their policy of stock reduction.

It was reported from New York on Monday that trading in lead futures will be resumed on May 26 as a result of the decision to decontrol the metal. No doubt zinc will follow, but there is, as yet, no break in the price as in lead. As we write, however, there is talk that the U.S. price of zinc may fall soon, and in that event the U.K. quotation would follow.

In the House of Commons last week it was revealed that the Ministry's price of zinc is now under review. A question had been asked bearing on the comparison of the U.K. official prices with those ruling abroad, and the reply given by the Parliamentary Secretary to the Board of Trade included the information about zinc.

It was also pointed out that the Ministry's selling prices are based at present on replacement costs and that copper at any rate is not available in any quantity at 24½ cents (£196). The Ministry, of course, buys on the basis of 27½ cents, which is the U.S. f.a.s. price and is equal to £220.

London Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £957 to £958; Friday, £964 to £966; Monday, £968 to £970; Tuesday, £962 10s. to £964 10s.; Wednesday, £960 to £960 10s.

Three Months—Thursday, £964 10s. to £955; Friday, £957 10s. to £958; Monday, £962 to £962 10s.; Tuesday, £957 to £958; Wednesday, £952 10s. to £953.

Changes of Name

The undermentioned companies have recently changed their names. The new titles are shown in parentheses.

EXACTOOLS, LIMITED, Birmingham (Track - Power, Limited).

GENERAL ENGINEERING (NORFOLK), LIMITED, Hastings (Getag, Limited).

IRETON, LIMITED, engineers, of Stevenage (Herts) (Johnson Ireton, Limited).

U.C. LUBRICANTs (ENGINEERS), LIMITED, Penarth (Glam) (Marindaqua, Limited).

FLOW MANAGEMENT, LIMITED, London, E.C.2 (Flow Machinery & Equipment, Limited).

ENGRAVING MACHINE TOOL COMPANY, LIMITED, London, W.1 (E.M. Tool Company, Limited).

BROMET METAL WORKS, LIMITED, Southall (Middx) (Broadway Aircraft Engineering Company, Limited).

SHEEPBRIDGE STOKES ENGINE LINERS, LIMITED, Chesterfield (Sheepbridge Engine Repairs, Limited).

DAVID DOWLING & COMPANY, LIMITED, general and electrical engineers, of Ilford (Essex) (David Dowling, Limited).

JOHNSON-IRETON, LIMITED, constructional, mechanical, and general engineers, etc., of London S.W.1 (Johnson-Ireton (Holdings), Limited).

BRIMLEY & COMPANY (BIRKENHEAD), LIMITED, dealers in tubes, engineers' plant, etc., of Birkenhead (Brimley & Company, Limited).

J. A. WELLSTEAD, LIMITED, mechanical, electrical, marine, and general engineers, etc., of Bournemouth (G. M. Hart & Company, Limited).

Steel from the Sea

Steel plates produced by mills in Lanarkshire during 1943 were sent to Belfast for the construction of the Royal Mail Lines vessel, Pampas, are returning home after being several years at the bottom of the sea. The Pampas, a vessel of 8,244 tons, was bombed and sunk in Malta harbour during the war and never refloated. Over 12 months ago, however, the Glasgow firm of Turner & Hickman started operations to salvage the vessel and secure the steel so urgently needed for the Scottish mills. Three cargoes of steel scrap have been shipped back to Britain.

Midland Foundry Long-service Presentations

At a social gathering held in the canteen of Edward Matthews Limited, ironfounders of Bilston, Staffs, Mrs. Ida Matthews made 33 presentations to long-service employees. The awards took the form of either savings certificates or gold wristlet watches. A presentation of a silver salver and a cigarette box was also made to Mr. Bertram Kidson, the chairman of the Company.